

## TABLE OF CONTENTS

[Overview](#)

[Visual/Mechanical Inspection](#)

[General Troubleshooting](#)

[Functional Overview](#)

[Take Apart Procedure](#)

- [Bottom Case](#)
- [Clutch Covers](#)
- [Audio Board](#)
- [Logic Board](#)
- [Heat Sink](#)
- [eDP Flex Cable](#)
- [Vent/Antenna Module](#)
- [Fans](#)
- [Touch ID Board](#)
- [Touch ID Shim](#)
- [Input/Output \(I/O\) Boards](#)
- [Display Assembly](#)
- [Lid Angle Sensor \(LAS\) Module](#)
- [Top Case with Battery](#)

[Exploded View](#)

[Screw Chart and Location Diagrams](#)

# Overview

## Overview for MacBook Pro (16-inch, 2019)



### What's New

- **Processor:** 2.6GHz 6-core Intel Core i7 or 2.3GHz 8-core Intel Core i9 processor, configurable to 2.4GHz 8-core Intel Core i9 processor
- **Retina Display:** 16-inch (diagonal) with True Tone
- **Graphics Cards:** AMD Radeon Pro 5300M and AMD Radeon Pro 5500M
- **Storage:** 512GB, 1TB, 2TB, 4TB, or 8TB onboard flash storage
- **Memory:** 16GB, 32GB, or 64GB of 2667MHz DDR4 onboard, not user installable
- **Camera:** integrated camera and ambient light sensor
- **Apple T2 Security Chip:**
  - Secure Enclave
  - Secure boot
  - Encrypted storage
- **Diagnostics:**
  - Apple Service Toolkit version 2 (AST 2)
  - The [Trackpad Calibration Check](#) must be performed after every repair.
  - The System Configuration **must** be performed after a top case, logic board, Touch ID board, or display assembly repair.
  - The Lid Angle Sensor (LAS) suite must be performed after a LAS module has been replaced.

This computer model's design requires special service considerations:

- **Important:** Only Apple-certified technicians should repair this computer.  
**System Configuration:** When replacing a top case, logic board, Touch ID board, or display assembly, the repair is not complete until the System Configuration has been performed. After putting the computer in DFU mode, the lid must be closed to perform System Configuration.  
**Startup and Power:** There is no startup sound. The following actions automatically turn on the computer:
  - - Lifting the lid
    - Connecting your Mac to a power adapter while the lid is open
    - Connecting your Mac to a power adapter while the lid is closed and it's connected to an external display
    - Pressing any key
    - Pressing the trackpad
  - **Battery Safety:** Before beginning any repair, install the battery cover, disconnect the battery cable from the logic board, and remove the BMU screw.
  - **Battery Service:** The battery is not a replaceable part. Never remove the battery from the top case. To replace a battery, you must replace the top case.
  - **Bottom Case:** The bottom case must be serviced with the bottom case removal/install fixture kit (076-00290)
  - **Logic Board and Touch ID Board:** The logic board and Touch ID board are paired. When the logic board is replaced, the Touch ID board must also be replaced. **However**, the logic board does not need to be replaced when only the Touch ID board is replaced.
  - **Touch ID Board:** The Touch ID board requires a special tool for reassembly: Touch ID alignment tool (923-03032).
  - **Display Assembly and Lid Angle Sensor (LAS) module:** When the display assembly is replaced, the LAS must also be replaced. **However**, the display assembly does not need to be replaced when the LAS is replaced.
  - **Top Case:**
    - The top case comes with the battery, keyboard, trackpad, microphone, speakers, trackpad flex cable, and keyboard flex cable. Returned top cases must be packaged according to strict guidelines. If the battery, keyboard, microphone, or trackpad must be replaced, you must replace the top case. Repairs must be done in a designated area for lithium polymer battery repairs.
    - Regional top cases have the same base part number, but they include a language code prefix (for example, Italian = T661-13161). Be sure to choose the correct keyboard language when ordering a top case.
  - **Trackpad Calibration Check:** The calibration of the Force Touch trackpad must be verified after every repair.
  - **Thermal Ducts:** The fan ducts are rubber gaskets that sit on top of the fans. They are fragile and held down with adhesive. Use care when lifting them to access the fans.
  - **Bottom Case Removal Kit:** An extension kit (076-00459) for the bottom case removal kit is required to remove the bottom case.
  - **Keycaps:** For keycap replacement instructions, refer to [\\_Keycap Replacement](#).
  - **Firmware Password:** Only technicians at Apple Stores or Apple Authorized Service Providers can unlock the computer when protected by a firmware password.

## Starter Kits

The following kits are needed to service this computer:

- Battery Safety Kit,
- Battery Cover, 923-03891, package of two
- Bottom case removal/install fixture kit, 076-00290
- Bottom Case Extension Kit, 076-00459
- Touch ID alignment kit, 923-03032

## Use Software Update

MacBook Pro (16-inch, 2019) ships with a model-specific version of macOS. Using Software Update, check for and apply the latest software and firmware updates.

## Serial Number Locations

The system serial number and model number are located on the bottom case. Turn over the computer to view the numbers etched on the bottom case near the hinge.

**Note:** Bar code readers can be used to read serial numbers inside the computer.

### Model and EMC Numbers

Models	Model Number	EMC Number
<b>2016</b>		
MacBook Pro (13-inch, 2016, Two Thunderbolt 3 Ports)	<b>A1708</b>	<b>2978</b>
MacBook Pro (13-inch, 2016, Four Thunderbolt 3 Ports)	<b>A1706</b>	<b>307</b>
MacBook Pro (15-inch, 2016)	<b>A1707</b>	<b>3072</b>
<b>2017</b>		
MacBook Pro (13-inch, 2017, Two Thunderbolt 3 Ports)	<b>A1708</b>	<b>3164</b>
MacBook Pro (13-inch, 2017, Four Thunderbolt 3 Ports)	<b>A1706</b>	<b>3163</b>
MacBook Pro (15-inch, 2017)	<b>A1707</b>	<b>3162</b>
<b>2018</b>		
MacBook Pro (13-inch, 2018, Four Thunderbolt 3 Ports)	<b>A1989</b>	<b>3214</b>
MacBook Pro (15-inch, 2018)	<b>A1990</b>	<b>3215</b>
<b>2019</b>		
MacBook Pro (13-inch, 2019, Two Thunderbolt 3 Ports)	<b>A2159</b>	<b>3301</b>
MacBook Pro (13-inch, 2019, Four Thunderbolt 3 Ports)	<b>A1989</b>	<b>3358</b>
MacBook Pro (15-inch, 2019)	<b>A1990</b>	<b>3359</b>
MacBook Pro (16-inch, 2019)	<b>A2141</b>	<b>3347</b>





### Transferring the System Serial Number

When replacing a bottom case, retain the user's original bottom case until the repair is complete. Before installing a replacement bottom case, use a fine-tip permanent marker to write the original system serial number inside the bottom case.



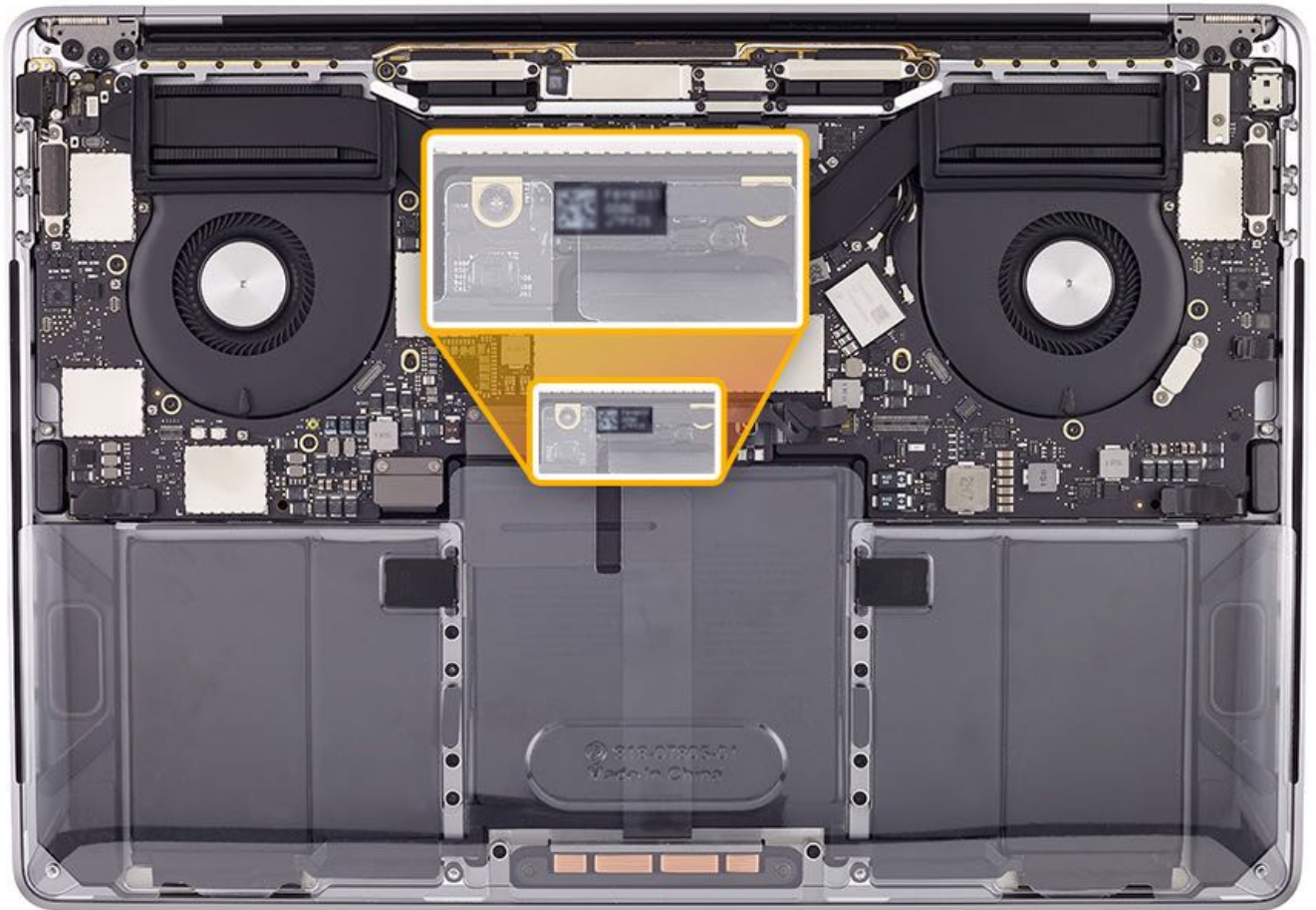
### Battery Serial Number

Copy the original battery serial number when reporting a top case return to Apple. Do not copy the replacement serial number.

An example of a MacBook Pro (13-inch, 2016 and 2017) and MacBook Pro (13-inch, 2019, Two Thunderbolt 3 Ports) battery serial number, located underneath the trackpad flex cable, is shown below. Carefully peel back the trackpad flex cable to view the battery serial number.



An example of a MacBook Pro (13-inch, 2018 and 2019, Four Thunderbolt 3 Ports) battery serial number, located on the BMU board, is shown below.



An example of a MacBook Pro (15-inch, 2016, 2017, 2018, 2019) and MacBook Pro (16-inch, 2019) battery serial number, located on the BMU board, is shown below.

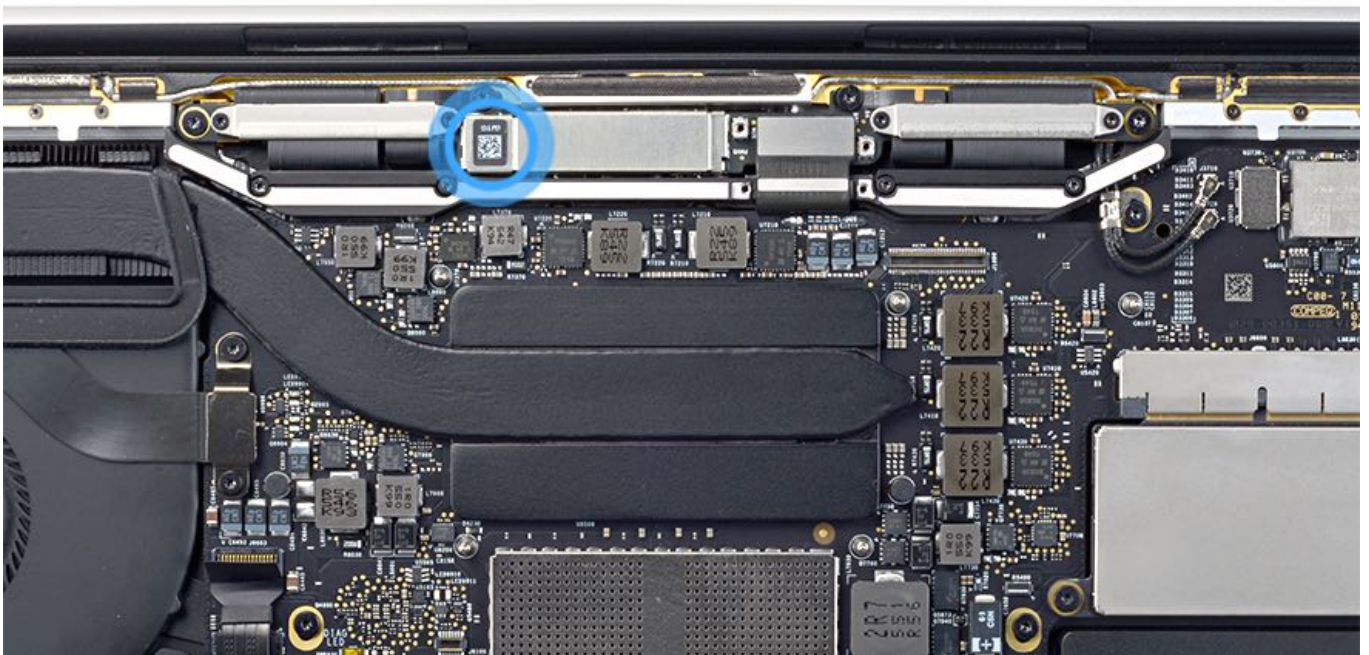




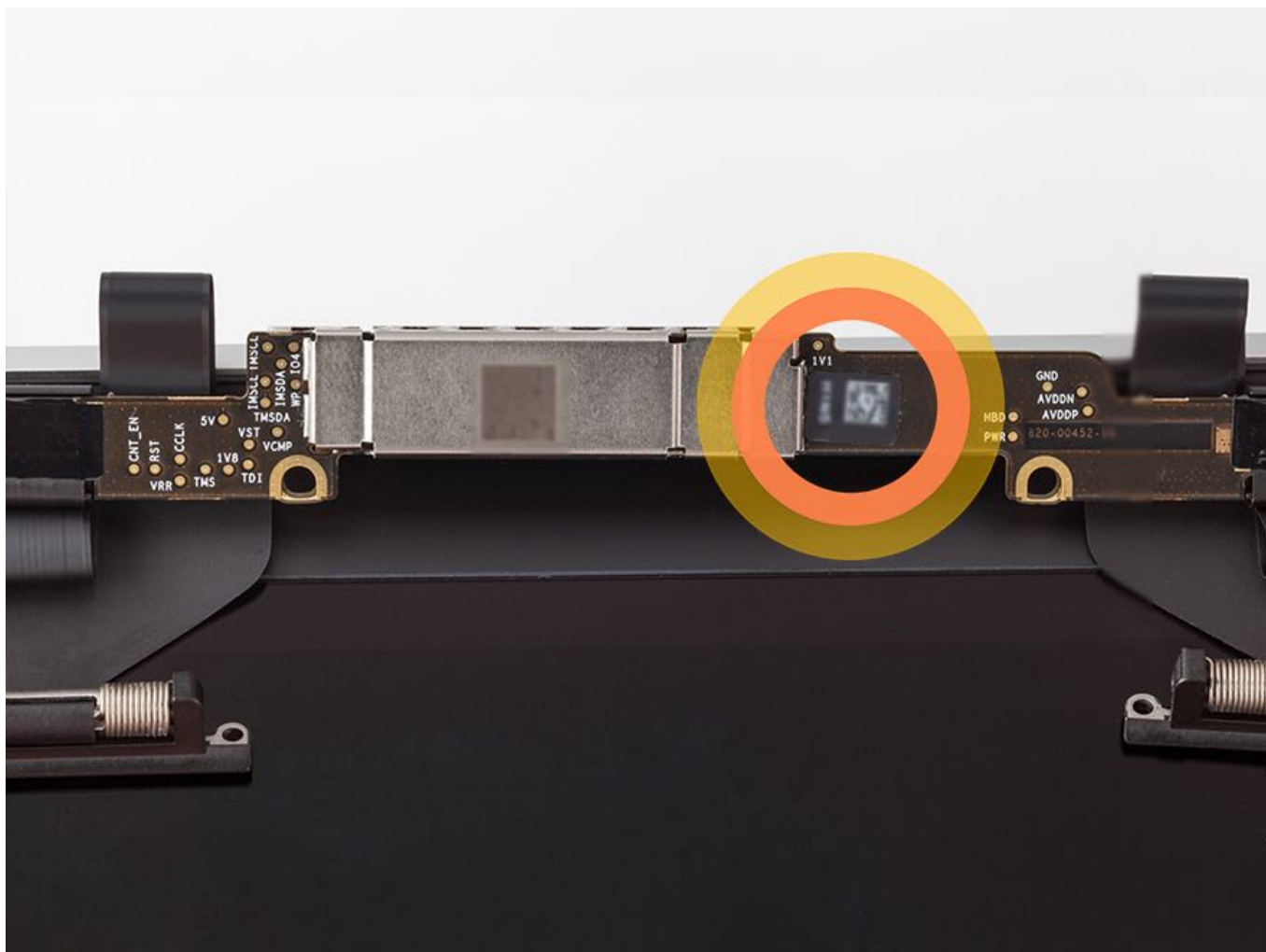
### Display Assembly Serial Number

The display assembly serial number is located on the TCON board.

An example of a MacBook Pro (13-inch, 2016, 2017, 2018, 2019) and MacBook Pro (16-inch, 2019) display assembly serial number is shown below.



An example of a MacBook Pro (15-inch, 2016, 2017, 2018, 2019) display assembly serial number is shown below.



# Battery Handling and Storage

## Battery Handling and Storage for MacBook Pro (2016, 2017, 2018, 2019)

### Best Practices

The battery contains several soft battery cells. Do not press the battery cells with your fingers, and do not handle the battery pack in any way that might apply any physical pressure to the cells.

- Always attach the battery cover to the battery immediately after removing the bottom case and before beginning any repair. Make sure all snaps on the battery cover are secure. Refer to the following list for battery cover part numbers:
  - MacBook Pro (13-inch, 2016, 2017, 2019 Two Thunderbolt 3 Ports): **923-01318**
  - MacBook Pro (13-inch, 2016 and 2017, Four Thunderbolt 3 Ports): **923-01319**
  - MacBook Pro (13-inch, 2018 and 2019, Four Thunderbolt 3 Ports): **923-02533**
  - MacBook Pro (15-inch, 2016 and 2017): **923-01320**
  - MacBook Pro (15-inch, 2018 and 2019): **923-02532**
  - MacBook Pro (16-inch, 2019): **923-03891**
- Disconnect the battery cable and remove the battery management unit (BMU) screw from the logic board whenever the bottom case is removed. Keep the battery cable disconnected and BMU screw removed during all part removal and reassembly. Reconnect the battery cable and reinstall the BMU screw just before installing the bottom case.
- Do not use a damaged battery cover. If the battery cover is damaged, replace it.
- Remove the battery cover just before installing the computer's bottom case. Keep the battery cover on the battery at all other times.
- Do not drop a top case assembly with battery. If the top case has been dropped, replace it.

### Battery Covers

MacBook Pro (16-inch, 2019): **923-03891**



MacBook Pro (13-inch, 2016, 2017, and 2019 Two Thunderbolt 3 Ports): **923-01318**



MacBook Pro (13-inch, 2016 and 2017, Four Thunderbolt 3 Ports): **923-01319**



MacBook Pro (13-inch, 2018 and 2019, Four Thunderbolt 3 Ports): **923-02533**



MacBook Pro (15-inch, 2016 and 2017): **923-01320**



MacBook Pro (15-inch, 2018 and 2019): **923-02532**



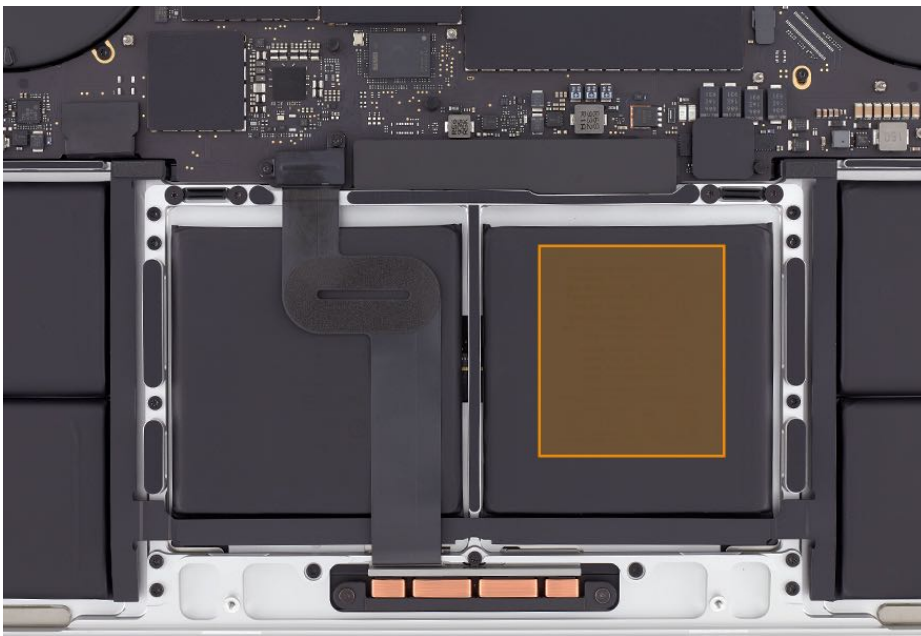




1. Verify that the packaging is in good condition: that labels are present, legible, and intact, and that the box is well structured and strong.
2. If the box is in good condition but needs a packing list, print a new packing list .
3. If the box is in poor condition, order a replacement box kit (606-0104). The kit includes the outer cardboard box, foam frame, two foam pads, labels, and an ESD or plastic bag.
4. Reuse the battery cover from the original top case removal. Order a new battery cover if needed.
5. Make sure the battery cover is securely attached to the battery. Install the battery cover as soon as the bottom case is removed and keep it in place for all subsequent part removals.
6. For MacBook Pro (13-inch, 2016, 2017, and 2019, Two Thunderbolt 3 Ports) and MacBook Pro (16-inch, 2019), the serial number is located on the battery. For MacBook Pro (13-inch, 2018 and 2019, Four Thunderbolt 3 Ports) and MacBook Pro (15-inch, 2016, 2017, 2018, and 2019), the serial number is located on the BMU board. Scan or copy the original battery serial number when reporting the return of the top case assembly with battery to Apple.

#### **MacBook Pro (16-inch, 2019)**

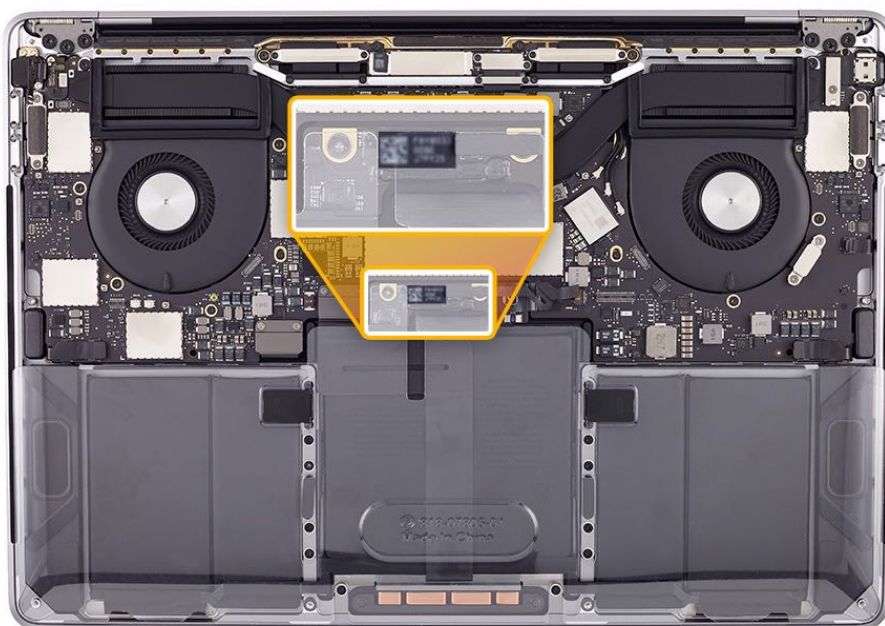




**MacBook Pro (13-inch, 2016, 2017, and 2019, Two Thunderbolt 3 Ports)**



**MacBook Pro (13-inch, 2018 and 2019, Four Thunderbolt 3 Ports)**



**MacBook Pro (15-inch, 2016, 2017, 2018, 2019)**



1. Place the top case with covered battery inside the bag.
2. Fold over the bag and seal it closed with the yellow ESD sticker. If the sticker is not available, use tape.
3. Place wrapped top case on bottom foam pad within inner foam frame inside cardboard box.
4. **Important:** When placing the wrapped top case in the box, make sure the battery is face up and at the front opening of the box.



5. Place the second foam pad over the wrapped top case.





5.

6. Close the box and seal it with tape. Do not use staples.



6.

7. Make sure the caution label and packing list are attached to the box.
8. Attach a shipping label and return the top case assembly with battery using normal shipping procedures.



8.



# Data Transfer for Macs with the Apple T2 Security Chip

Desktops and notebooks that have the Apple T2 Security Chip include security features that require a specific process for transferring data. Data from a damaged logic board can sometimes be captured and transferred before any service.

## Important:

- This procedure only allows data transfer to an external drive. Moving data directly to a new T2 Mac is not supported.
- If a logic board or flash storage needs to be replaced, data recovery must be attempted before System Configuration is performed. After System Configuration has been performed, data recovery is no longer available.
- This process will leave the customer system in a recovery state that makes the system appear unresponsive.  
**Note:** Completing the repair and running System Configuration will resolve this. If a repair has not been performed, perform a restore using Apple Configurator 2.  
Files and folders cannot be modified or deleted from the customer computer volumes. Those volumes are intended to be read only.
- After the transfer process, some files such as .bin, .etc, .tmp, and .usr may be visible on the external hard drive. This is expected behavior. Do not delete or modify these files or folders as doing so may cause issues for the customer when they migrate information from the external hard drive back to the customer's computer.  
It can take 10–20 minutes for the external hard drive to be partitioned.  
Data is transferred at USB 2.0 speed. The length of time required to complete this process depends on how much data is on the drive. This process could take up to four days.
- When transfer is complete, return the hard drive with the customer's data to the customer. Explain how they can migrate their data back to their computer using migration assistant.
- 

## Tools:

- Power cord
- USB-C to USB-C Charge Cable included with portables (661-06670) or USB-A to USB-C Apple TV Restore Cable (923-00504)



- A host computer with:
  - macOS Catalina 10.15 or later.
  - Mac Configuration Utility (MCU) installed.
  - Internet connection .
- An external hard drive of equal or greater capacity than the installed system storage.  
**Note:** The hard drive will be configured and password protected with the customer's computer serial number during the process.

## Steps:

1. Verify that part 076-00399 Data Transfer Setup (Retail) or 076-00410 Data Transfer Setup - Transaction Only (ASP) has been added to the repair and saved.
2. Launch the [Diagnostic Console](#) and start an AST 2 diagnostic session using the customer computer serial number.

3. Connect the customer's computer to the host computer. If the host computer does not have a USB-C port, use a USB-C to USB-A cable. It is important to connect the USB-C cable to the correct port or the process will not run.

**Notebooks:** Use only the USB-C port closest to the caps lock key.



**iMac Pro:** Use only the USB-C port closest to the Ethernet port.



**Mac mini (2018):** Use only the USB-C port closest to the HDMI port.



**Mac Pro (2019):** Use only the USB-C port closest to the housing edge.



**Mac Pro (Rack, 2019):** Use only the USB-C port closest to the power button.

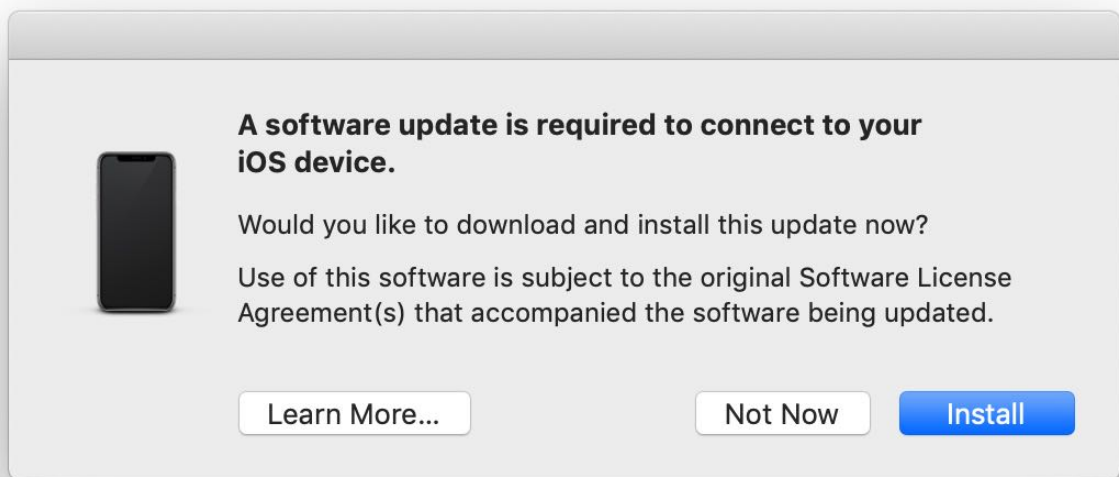




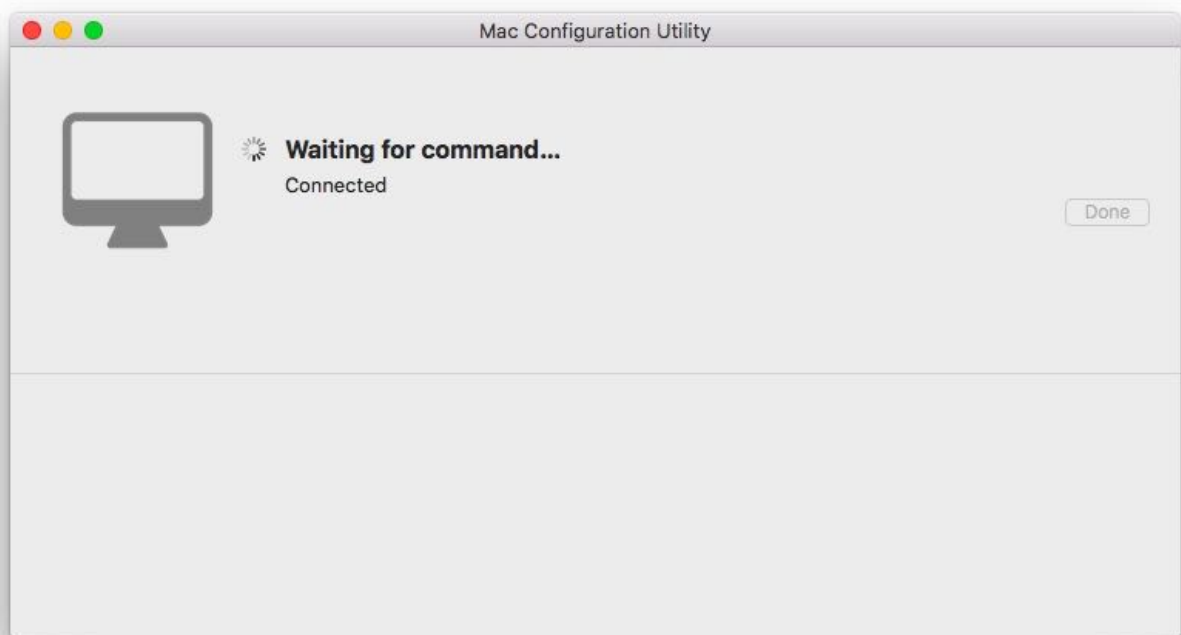
4. Verify that the host computer is turned on, connected to power, and connected to the Internet.
5. Start up the customer's computer in DFU mode.
  - **Desktops:** Press and hold the power button while connecting the power cord. Continue to hold the power button until you see the prompt appear in Mac Configuration Utility, which may take up to 10 seconds.
  - **Notebooks:** Press and hold the power button, then press and hold Left Control-Left Option-Right Shift until you see the prompt appear in Mac Configuration Utility, which may take up to 10 seconds.



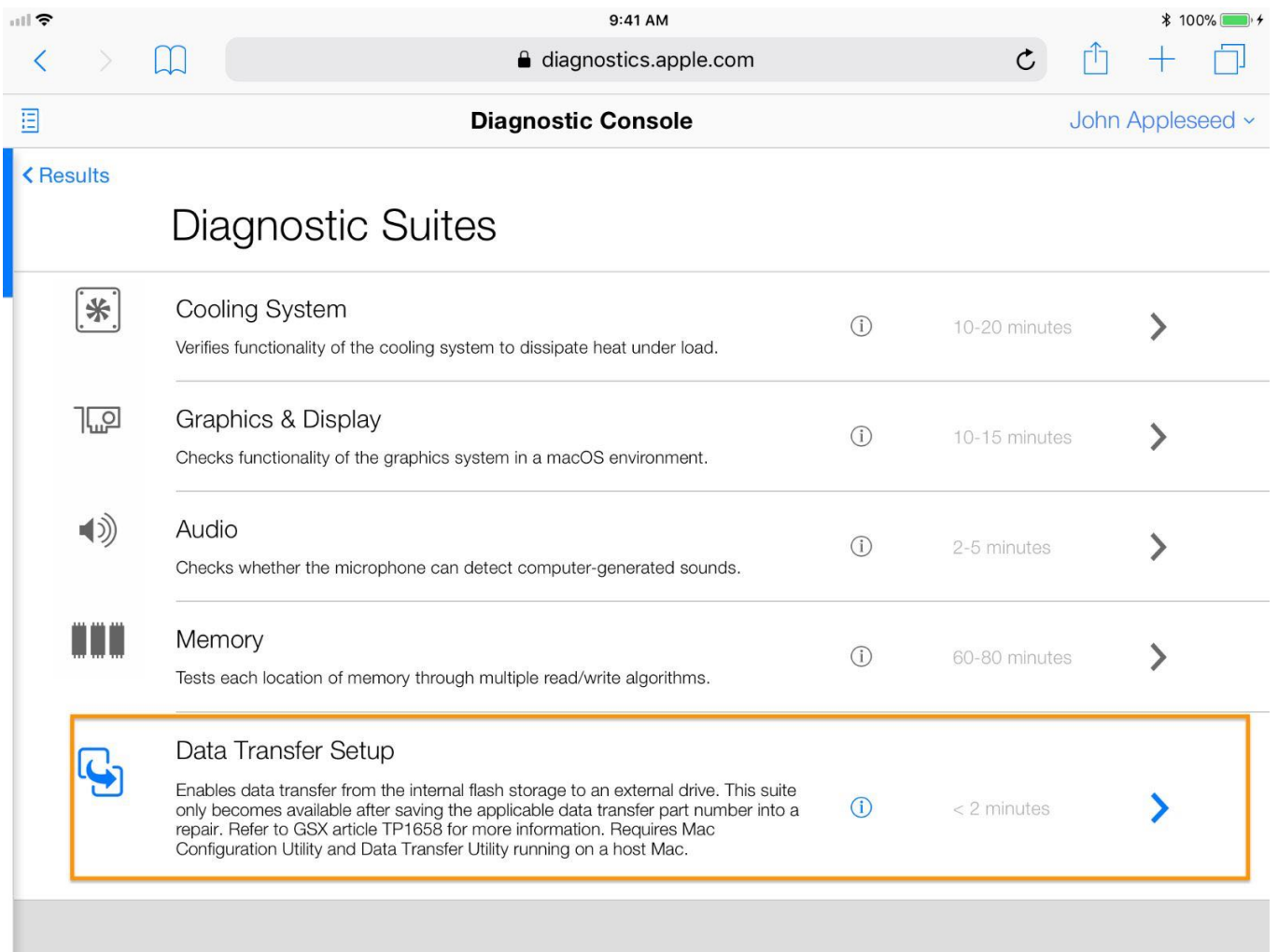
**Note:** An alert message may appear prompting a software update. Choose “Install.” After the installation is complete, continue to the next step in the System Configuration process.



6. MCU will automatically launch and a dialog box will appear on the host computer screen.



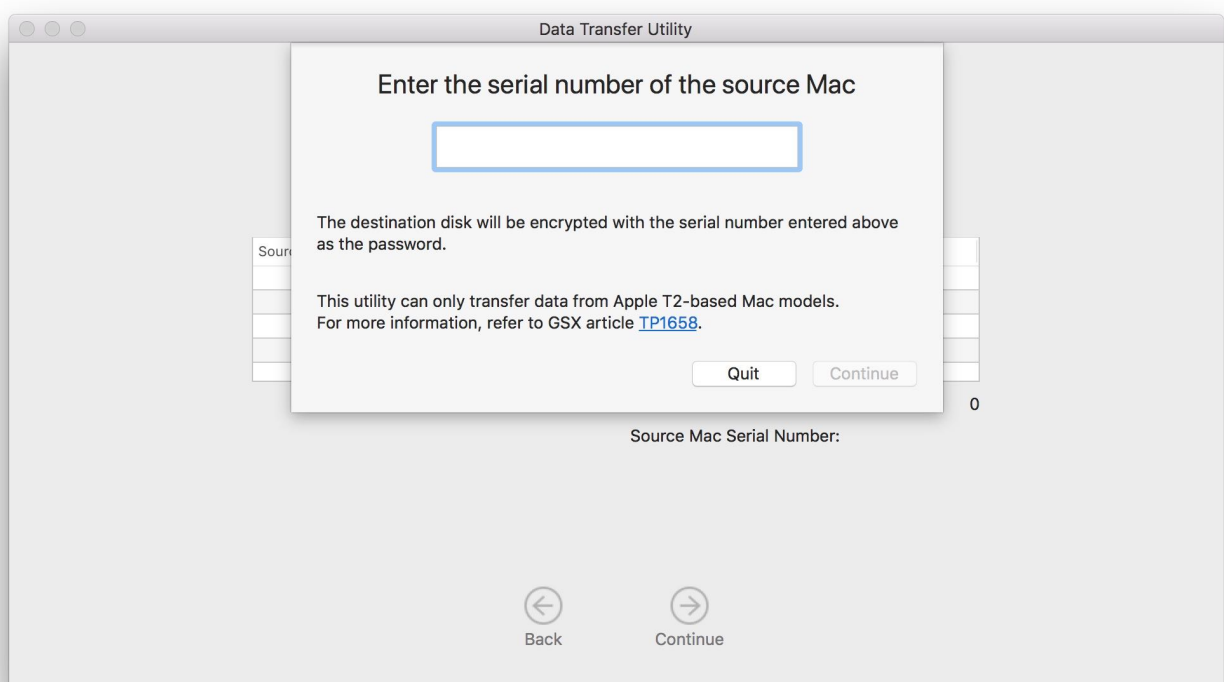
7. From the list of diagnostic suites in the Diagnostic Console, select Data Transfer Setup.



**Note:**

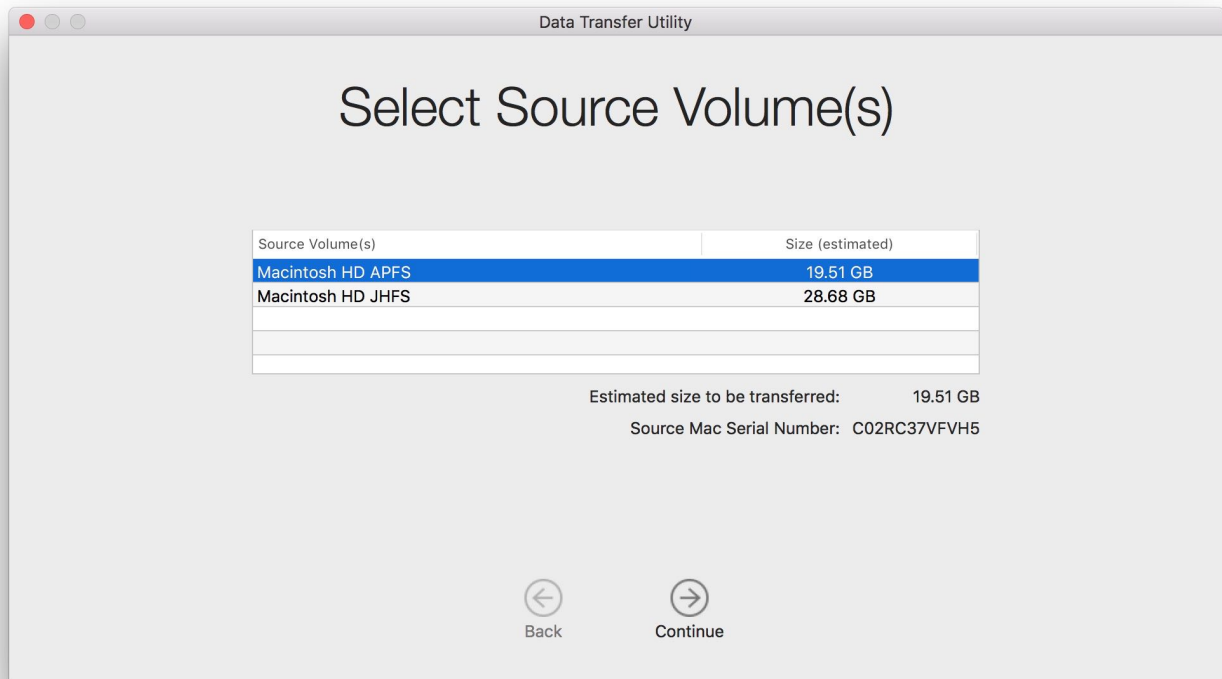
- If the customer has FileVault enabled, you will be prompted to enter the password.
- The customer's computer will not display anything on the screen to indicate status. The only observable indication will be when the drive mounts as an external volume on the host Mac running MCU.

8. Open the Data Transfer Utility app on the host machine and enter the serial number of the customer's computer.

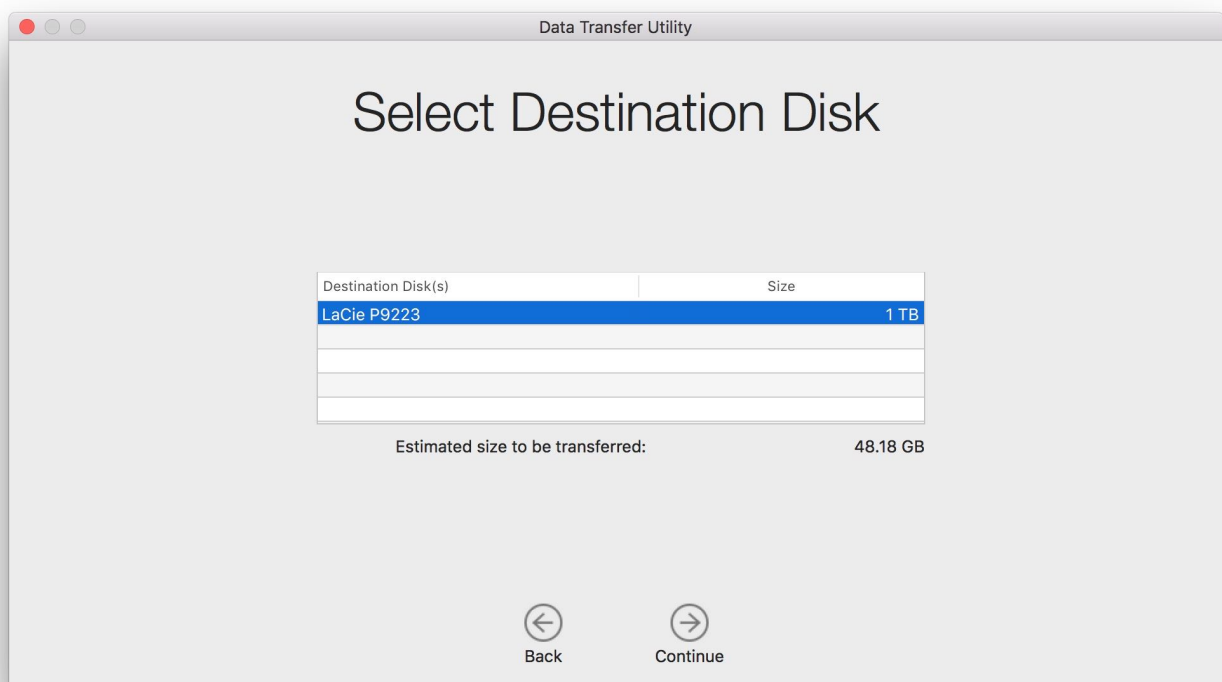


9. Select the source volume(s) and click Continue.

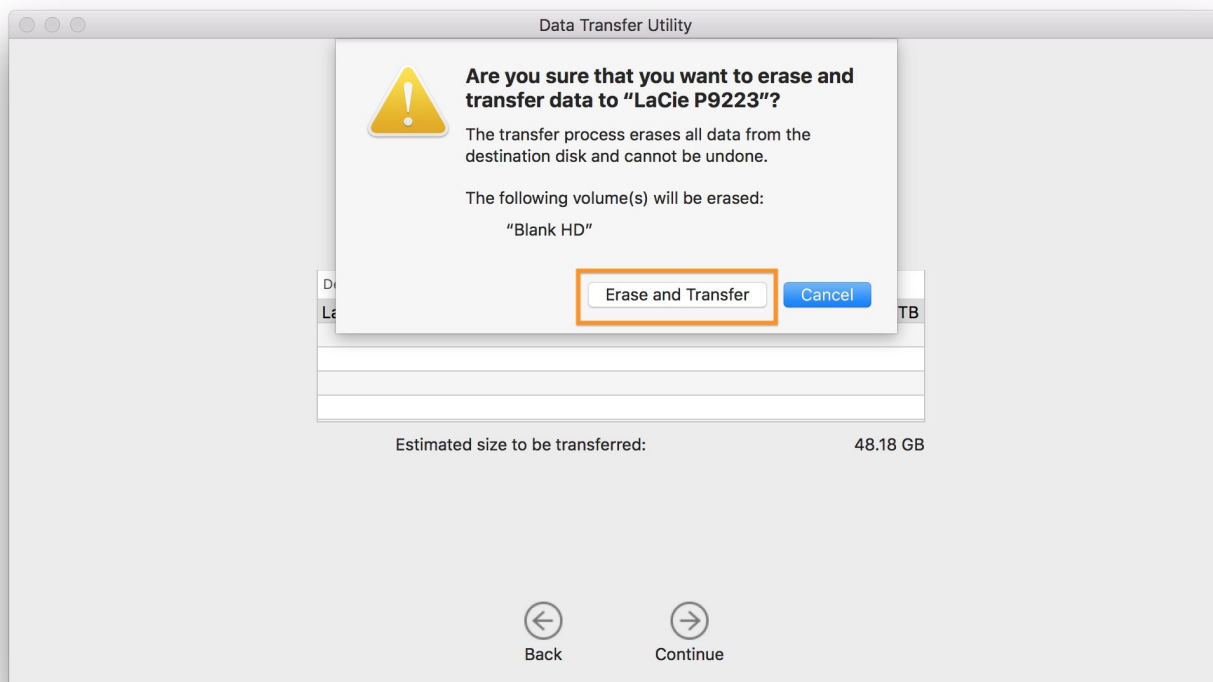
**Note:** If more than one source volume is available, multiple volumes can be selected to be transferred.



10. Connect an external hard drive to the host machine. Select the destination, and click Continue.

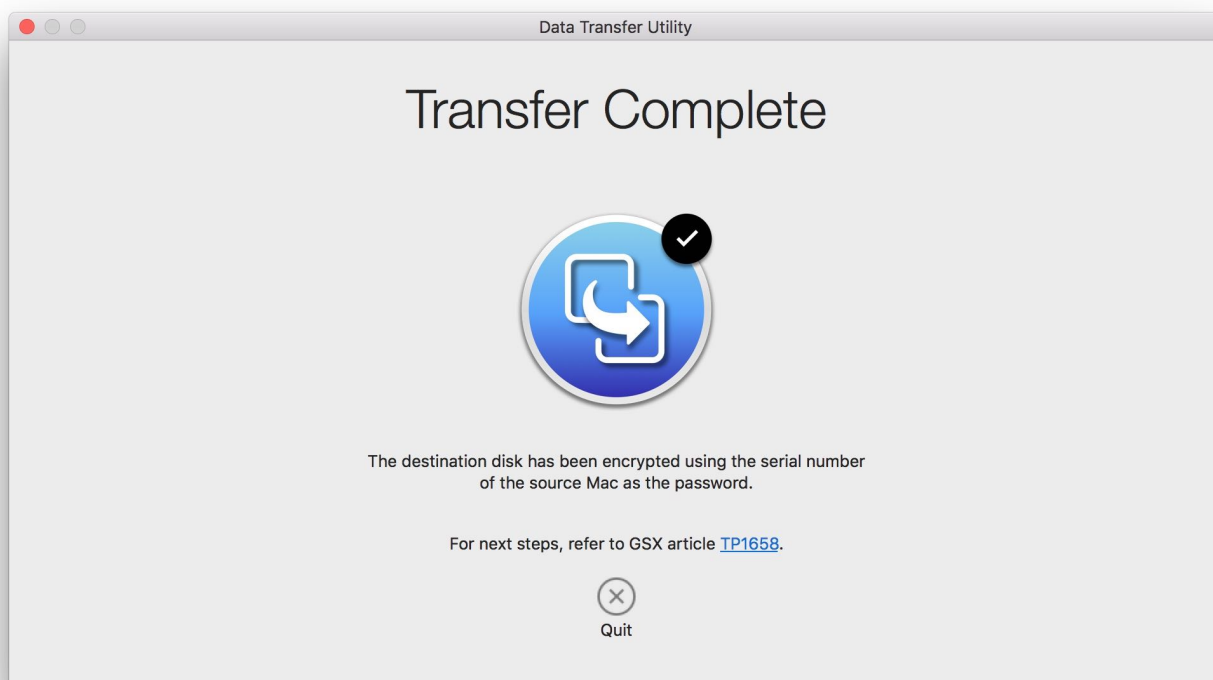


11. Click Erase and Transfer.

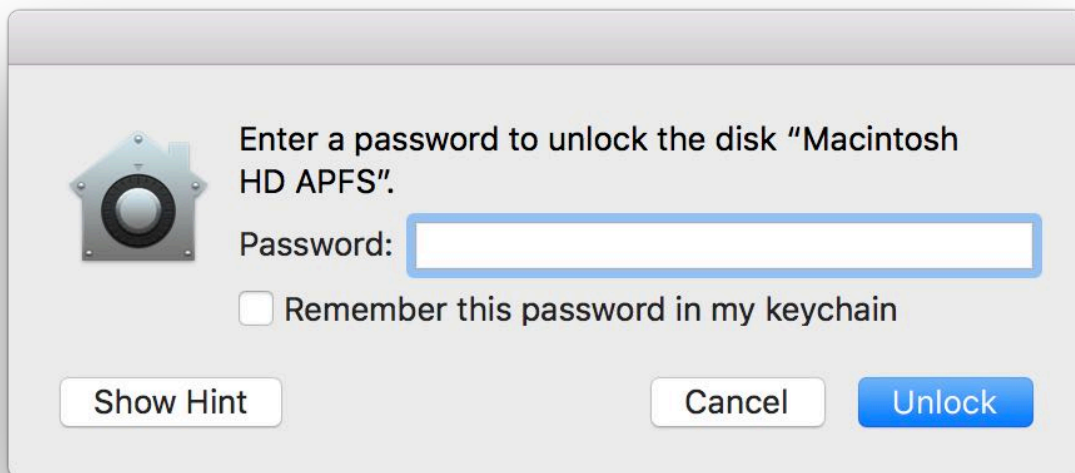


12. Transfer complete.

**Important:** Check the transfer is successful before closing the repair. Once the repair is closed this procedure cannot be performed again on the known bad (KBB) logic board.



13. Make sure the external drive is encrypted and the password works by unplugging it and plugging it back in.



**Important:** If the logic board has been replaced, data transfer using this process is no longer possible if System Configuration has been run and the repair has been closed.

#### **Troubleshooting Tips:**

If the Data Transfer Setup suite is unavailable, check the following:

1. Verify that the correct data migration part number has been added to the repair and saved.
2. Verify that the repair that includes the logic board has not been closed.
3. Verify that the correct serial number of the customer's computer was entered into the Diagnostic Console.
4. Verify that the serial number of the customer's computer was used to create the repair.
5. Verify that the device is correctly connected to the host Mac and that Mac Configuration Utility is running.
6. A correctly connected device will show as "Apple Mobile Device (DFU Mode)" in System Information > USB.
7. Do not use USB-C to USB-A cable (923-00504) combined with USB-C to USB Adapter (MJ1M2AM/A).

If the device does not complete the Data Transfer Setup suite, check the following:

1. Archive the AST 2 session, create a new one, and re-run the Data Transfer Setup suite.
2. Restart the host Mac.

If the Data Transfer Utility app does not show any volumes under Select Source Volume(s), check the following:

1. Verify volume(s) appear in Finder or Disk Utility.
2. Verify the correct serial number of the customer's computer was entered into the Data Transfer Utility app.

If the external hard drive is not being recognized by the Data Transfer Utility app, it may need to be initialized using Disk Utility.

# Visual/Mechanical Inspection (VMI) Guide for Mac Computers - Table of Contents

## Visual/Mechanical Inspection (VMI) Guide for Mac Computers - Table of Contents

- [Mac Displays](#)
- [Liquid Damage](#)
- [Power Adapters](#)
- [USB-C Cables](#)



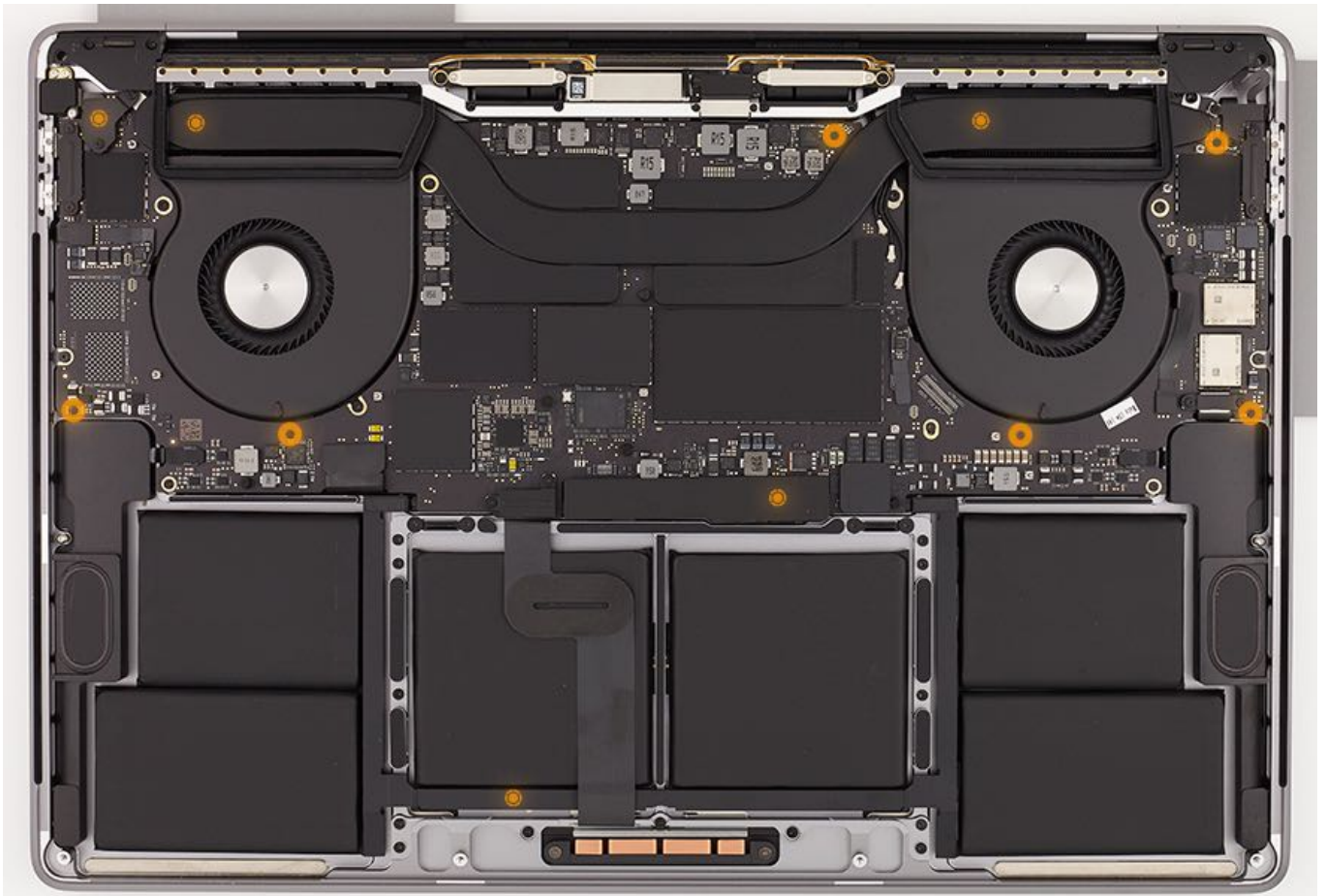
# Liquid Contact Indicators

## Liquid Contact Indicators for MacBook Pro (16-inch, 2019)

Liquid Contact Indicators (LCIs) help determine if a computer has been exposed to liquid. Represented by small white (traditional LCIs) or black (Ultraviolet LCIs) dots, LCIs change color when they come in contact with liquid, such as an accidental spill.

**Important:** An LCI is a tool that helps technicians identify if a product has been in contact with liquid. Technicians should not rely solely on this tool, but should perform a thorough examination for signs of liquid contact, such as corrosion.

- Dotted circles represent LCIs underneath a module





# How to Read Liquid Contact Indicators with Ultraviolet (UV) Light

## How to Read Liquid Contact Indicators with Ultraviolet (UV) Light

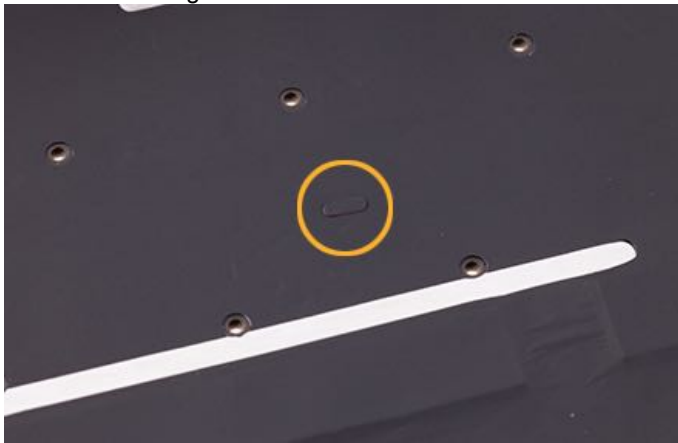
MacBook (Retina, 12-inch, 2017), MacBook Air (Retina, 13-inch, 2018 and 2019), and MacBook Pro (2018 and 2019) contain spill sensors called liquid contact indicators (LCIs). LCIs help discover accidental damage to the computer. They are black, and liquid contact is only visible with the use of a UV light. LCIs appear black under normal light and glow blue when highlighted with a UV light. They turn pink or produce a pink halo when they come in contact with liquid.

**Note:** MacBook Pro (15-inch, 2018 and 2019) also has one LCI that appears white and turns pink when it comes in contact with liquid.

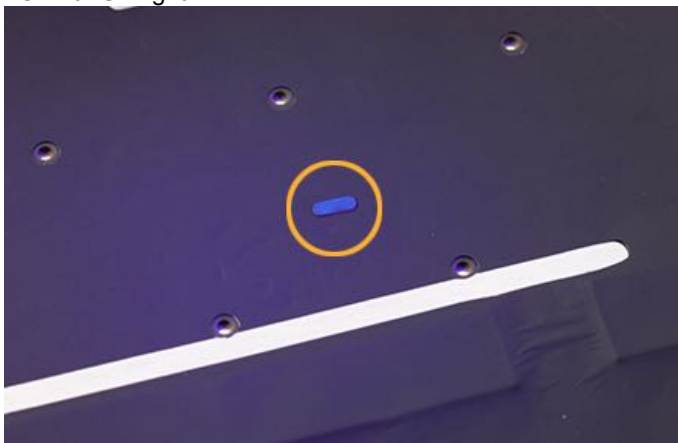
**Important:** A triggered LCI is not the only evidence of liquid contact. Be sure to inspect for corrosion or liquid residue during a quick check or repair.

### No Liquid Contact:

- LCI without UV light

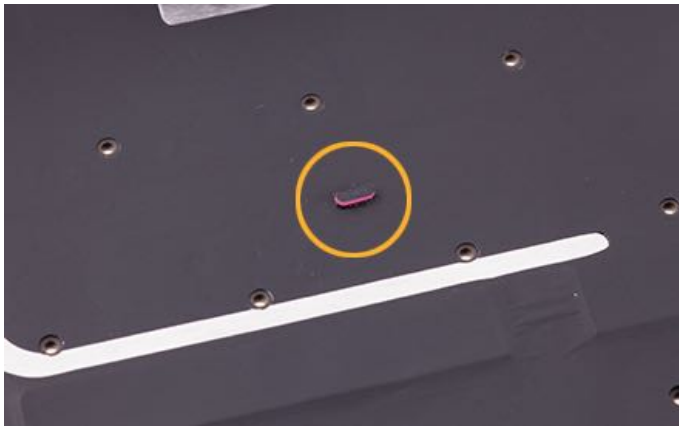


- LCI with UV light

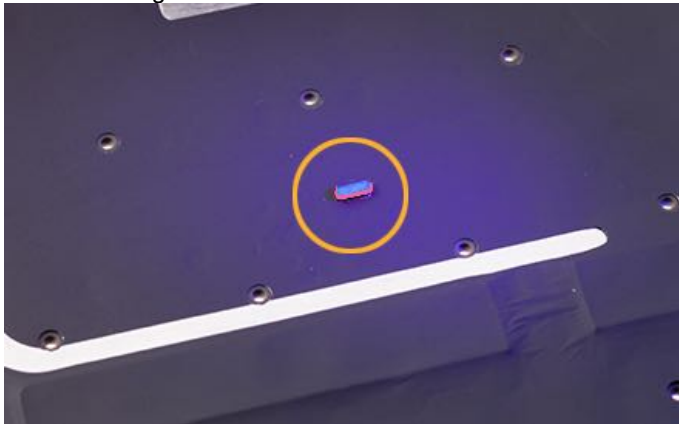


### Liquid Contact:

- LCI without UV light



- LCI with UV light



#### **Safety Information:**

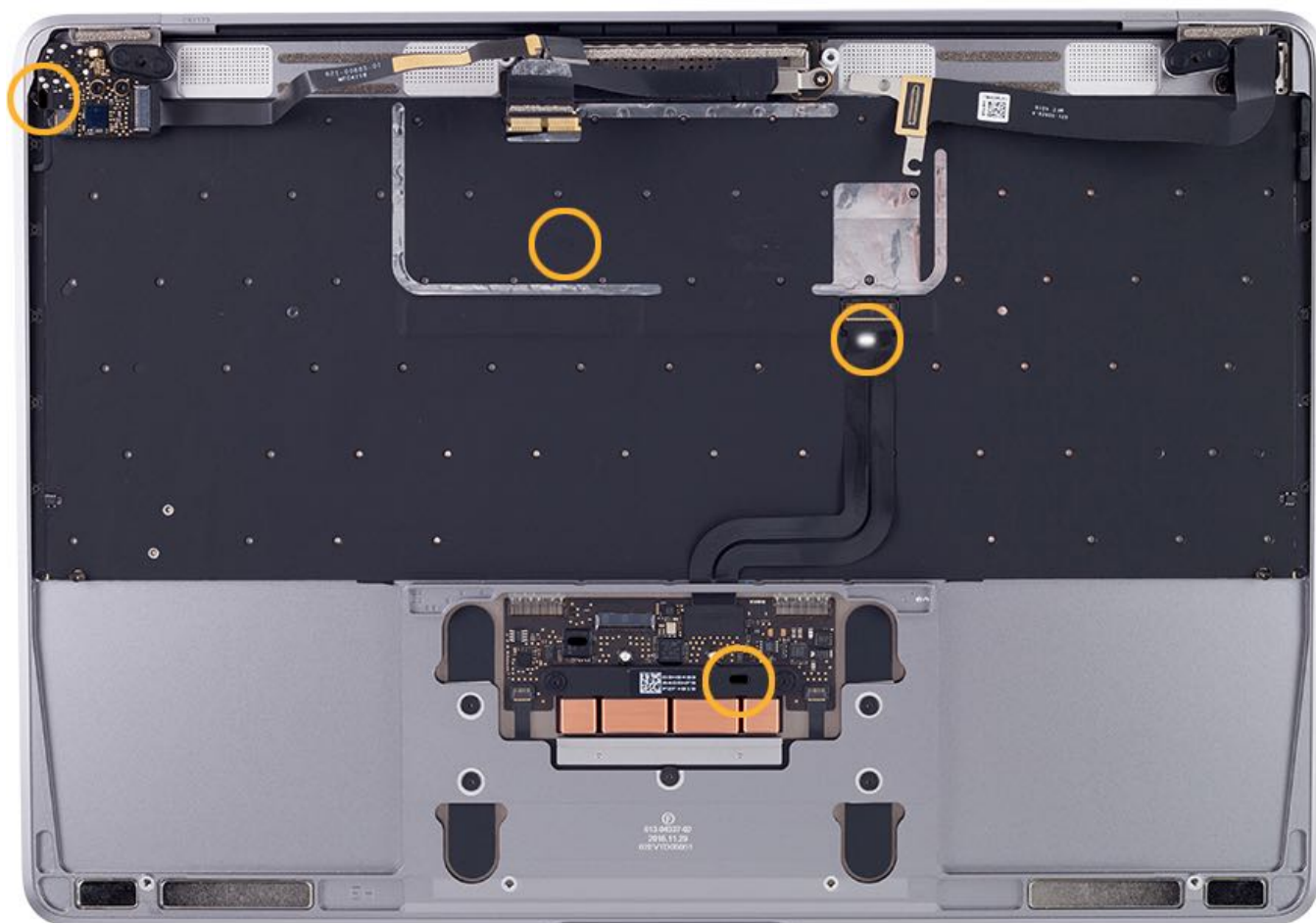
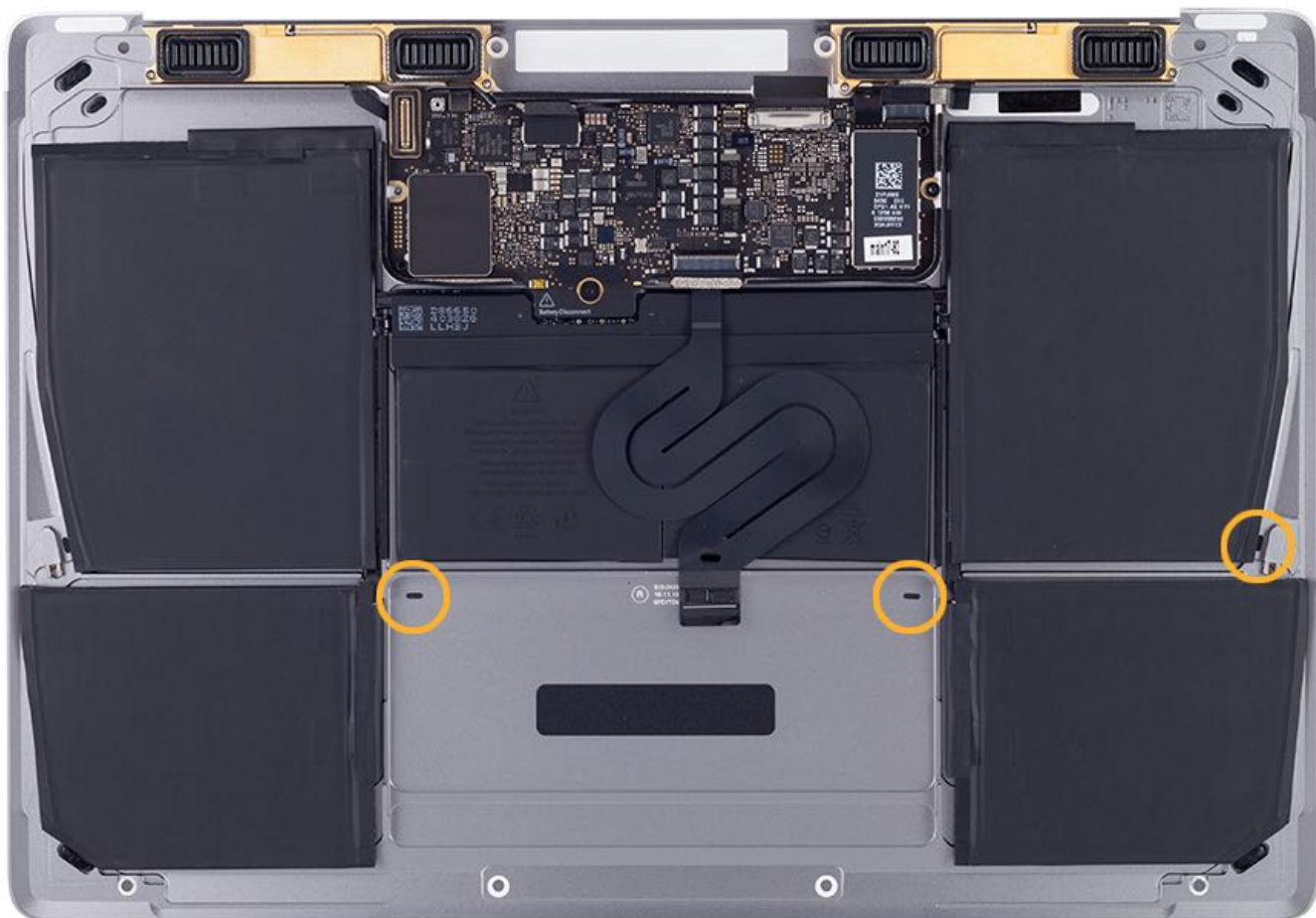
**Caution:** UV LCIs illuminate with the use of the Apple-approved UV light (923-01604). Follow safety precautions when using this tool:

- Do not remove the warning labels on the UV light.



- Do not shine the UV light in anyone's eyes or face.
- Avoid repeated exposure to the UV light.
- If a different UV light is used, safety glasses and gloves must be worn to avoid excessive exposure.

The following images show the general location of LCIs in a MacBook computer.



## Procedure

### Note:

- Ultraviolet LCIs are black. The black LCIs blend in with the rest of the computer. When in contact with liquid, the LCIs may swell and become easier to identify.
- When using the UV light, hold it 12 to 14 inches (30 to 35 centimeters) from the computer and shine it at an angle of 15 to 75 degrees.



**Warning:** While the UV light is shining, do not hold it close to your face or bend your head down to look closely at the LCIs.



1. Press the power button on the UV light.



2. Check the color of the LCI. Blue indicates an LCI that has not been triggered. A pink LCI or a pink halo around the LCI indicates that it has been triggered. Refer to visual examples at the top of this article.

# General Troubleshooting

## Update Software and Firmware

**Important:** Before troubleshooting, ensure the correct version of macOS is installed, and check for and apply the latest software and firmware updates. Computers sometimes exhibit symptoms that indicate the incorrect version of macOS is installed.

Firmware refers to software that is written into memory circuits such as flash memory, which will hold the software code indefinitely, even when power is removed from the hardware. Firmware on Intel-based Mac computers prior to computers with an Apple T2 Security Chip is designed to be updated if necessary by running macOS Software Update (available in the Apple ( ) menu under About This Mac) while the computer is connected to the Internet.

For computers with an Apple T2 Security Chip, separate SMC and EFI firmware images have now both been integrated into bridgeOS.

## Troubleshooting Techniques

For more information, go to [ATLAS](#) and enter “troubleshooting” in the search field.

## Hardware versus Software

To isolate a hardware issue from a software issue .

To troubleshoot a software issue .

# Quick Check Procedures

## Resetting the System Management Controller (SMC)

The System Management Controller (SMC) is a chip on the logic board that controls all power functions. On some Mac computers, the Apple T2 Security Chip integrates several controllers—such as the SMC, image signal processor, audio controller, and SSD controller. If the computer is experiencing any power issue, such as not starting up, not displaying video, sleep issues, or fan noise issues, resetting the SMC may resolve it.

**Note for iMac (2019 and earlier):** If the power button is pressed while the power cord is being inserted, the iMac will enter a mode that runs the fans at full speed.

**Note for Desktops with the Apple T2 Security Chip:** If the power button is pressed while the power cord is being inserted, the Mac will enter Device Firmware Upgrade (DFU) mode and will need to be restored.

## Resetting Nonvolatile RAM (NVRAM)

NVRAM stores certain system and device settings in a location that macOS can access quickly. Exactly which settings are stored in the computer's NVRAM varies depending on the type of computer, connected devices, and drives. To reset NVRAM:

## Starting Up in Safe Mode

Safe mode (sometimes called safe boot) is a way to start up a Mac so that it performs certain checks and prevents some software from automatically loading or opening. These changes can help resolve or isolate certain issues on the startup disk.

# LCD Pixel Anomalies

When displaying a single color over the screen area, the liquid crystal display (LCD) might show one or more pixels that are not properly lit.

LCD technology uses rows and columns of addressable points (pixels) that render text and images on the screen. Each pixel has three separate subpixels (red, green, and blue) that allow an image to render in full color. Each subpixel has a corresponding transistor responsible for turning the subpixel on and off.

Depending on the display size, there can be thousands or millions of subpixels on an LCD. For example, the LCD used in iMac (27-inch, Late 2013) has a display resolution of 2560 by 1440, which means there are 3.7 million pixels. Each pixel is made up of a red, a green, and a blue subpixel, resulting in over 11 million individual picture elements on the 27-inch display. Occasionally, a transistor may not work perfectly, resulting in the affected subpixel remaining off (dark) or on (bright). With the millions of subpixels on a display, it is possible to have a low number of such transistors on an LCD. In some cases, a small piece of dust or other foreign material may appear to be a pixel anomaly. Apple strives to use the highest-quality LCD displays in its products, but pixel anomalies can occur in a small percentage of them.

In some cases, pixel anomalies are caused by a piece of foreign material that is trapped inside the display or on the surface of the display or glass panel. Foreign material is typically irregular in shape and is usually most noticeable when viewed against a white background.

- For any computer, foreign material on the surface of the display or glass panel can easily be removed using a lint-free cloth.
- For any computer, foreign material trapped inside the display can only be resolved by replacing the entire display assembly.



# Sleep Status Tips

## Sleep Status Tips for MacBook (Retina, 12-inch, Early 2015 and later) and MacBook Pro (2016 and later)

These computer models do not have a sleep indicator light. To troubleshoot without one:

- Press and hold the Caps Lock key to wake the computer from sleep. The Caps Lock indicator light is a good indication of power.
- Check the haptic response of the trackpad. The trackpad will not have any haptic response when there is no power to the system, except for 2018 and 2019 models which will show a response if there is battery life or plugged into AC power.
- Open the display and press an alphanumeric key to wake the computer from sleep.
- A computer that has been in sleep mode for an extended period can consume the remaining battery charge. Restore power to the computer with a known-good power adapter. The computer will start up from a hibernation file and start up from where it left off.
- Use a USB-C to USB Adapter, USB-C Digital AV Multiport Adapter, or USB-C VGA Multiport Adapter to connect a USB device that has a power-on or activity indicator light. As power is restored to the USB and the computer wakes from sleep, the indicator light illuminates.  
**Note:** A USB-C to USB adapter may be used if power does not need to be supplied to the computer.
- Resetting the System Management Controller (SMC) instantly shuts down the computer, with some side effects:
  - If the computer is in sleep mode, it will start up from a hibernation file.
  - If the computer is running OS X or macOS during the SMC reset, data from open applications can be lost.
  - If the computer is already shutdown, there will be no side effects.

## MacBook Pro (16-inch, 2019)

- This computer model has a magnet on the left display clutch that regulates its sleep. If the MacBook Pro (16-inch, 2019) is not sleeping, check that the magnet is present. If the magnet is not present, the display assembly will need to be replaced.

## MacBook Pro (13-inch, 2018 and 2019, Four Thunderbolt 3 Ports), MacBook Pro (13-inch, 2019, Two Thunderbolt 3 Ports), MacBook Pro (15-inch, 2018 and 2019), MacBook Pro (16-inch, 2019), and MacBook Air (Retina, 13-inch, 2018 and 2019)

The troubleshooting steps listed above still apply for these computer models. Pressing any key or the trackpad, connecting to a power adapter, and opening the display will also start these computer models. Note the following behaviors when the computer is shutdown and the battery has some remaining charge:

- The Caps Lock indicator light may illuminate when pressed.
- The trackpad will provide a haptic response when pressed.
- The computer will start up when the display is opened.
- The computer will start up when the display is open and it is connected to a power adapter.

# Diagnostic Software

## Apple Service Toolkit 2 (AST 2)

AST 2 is a cloud-based diagnostic system that helps technicians triage and verify repairs for iOS devices and Mac computers released in June 2014 and later, except for MacBook Pro (Retina, Mid 2014). Technicians use AST 2 to initiate diagnostics wirelessly on a user's device using the Diagnostic Console (a web application on a Mac or iPad). Technicians can also view diagnostic results on the Diagnostic Console.

For computers with the Apple T2 Security Chip, System Configuration (found in AST 2) must be run after certain repairs for the repair to be complete. Failure to do so will result in an inoperative system and an incomplete repair.

An MRI (OS) diagnostic suite is available only for Mac notebook computers with the Apple T2 Security Chip.

# AST 2 MRI (OS) suite for Mac notebook computers with the Apple T2 Security Chip

This article provides information about and when to use AST 2 Mac Resource Inspector (MRI) OS for Mac notebook computers with the Apple T2 Security Chip.

## Information

An MRI (OS) diagnostic suite is now available only for Mac notebook computers with the Apple T2 Security Chip, which includes these models:

### MacBook Air

- MacBook Air (Retina, 13-inch, 2018)
- MacBook Air (Retina, 13-inch, 2019)

### MacBook Pro (13-inch)

- MacBook Pro (13-inch, 2019, Two Thunderbolt 3 Ports)
- MacBook Pro (13-inch, 2018, Four Thunderbolt 3 Ports)
- MacBook Pro (13-inch, 2019, Four Thunderbolt 3 Ports)

### MacBook Pro (15-inch)

- MacBook Pro (15-inch, 2018)
- MacBook Pro (15-inch, 2019)

### MacBook Pro (16-inch)

- MacBook Pro (16-inch, 2019)

The Apple T2 Security Chip inside these computers controls the following components which require a known-good macOS with which to test:

- Audio
- Camera
- Flash Storage
- Power Management
- Secure element
- Touch ID
- Trackpad
- Lid Angle Sensor (LAS) on MacBook Pro (16-inch, 2019)

MRI (OS) uses a known-good macOS to check for the presence of T2-related hardware components on these computers.

Mac notebook computers with the Apple T2 Security Chip will continue to display MRI (EFI) as an available diagnostic suite, and will have an additional selection of MRI (OS) on the AST 2 Diagnostic Console.

MRI (OS) will only be available as a choice within the Diagnostic Console for Mac notebook computers with the Apple T2 Security Chip. This suite is not available or needed for any other Mac models.

All other Mac notebook and desktop computers that are supported by AST 2 should continue to use MRI (EFI).


9:41 AM 100%

diagnostics.apple.com

AST 2 Diagnostic Console Jane ▾

## Diagnostic Suites

TRIAGE


**Mac Resource Inspector (EFI)**

Quick triage tool that checks for the presence of hardware components and performs a series of short tests to verify hardware functionality using EFI.

3-5 minutes >

Suggested use: during triage to provide a quick health check of hardware that can be tested using EFI.

Show Less...


**Mac Resource Inspector (OS)**

Triage tool that checks for the presence of T2-related hardware components that require an OS to test. Refer to GSX article TP1748 for more information.

6-8 minutes >

Suggested use: during triage of components that require an OS to test such as ambient light sensor, audio, bluetooth, camera, trackpad, and Touch ID.

Show Less...

**Storage (OS)**

**Important:** The MRI (OS) suite requires up to eight minutes to complete under normal network conditions.

### When to use the MRI (OS) diagnostic suite

Mac notebook computers with the Apple T2 Security Chip may require running tests only available from within macOS.

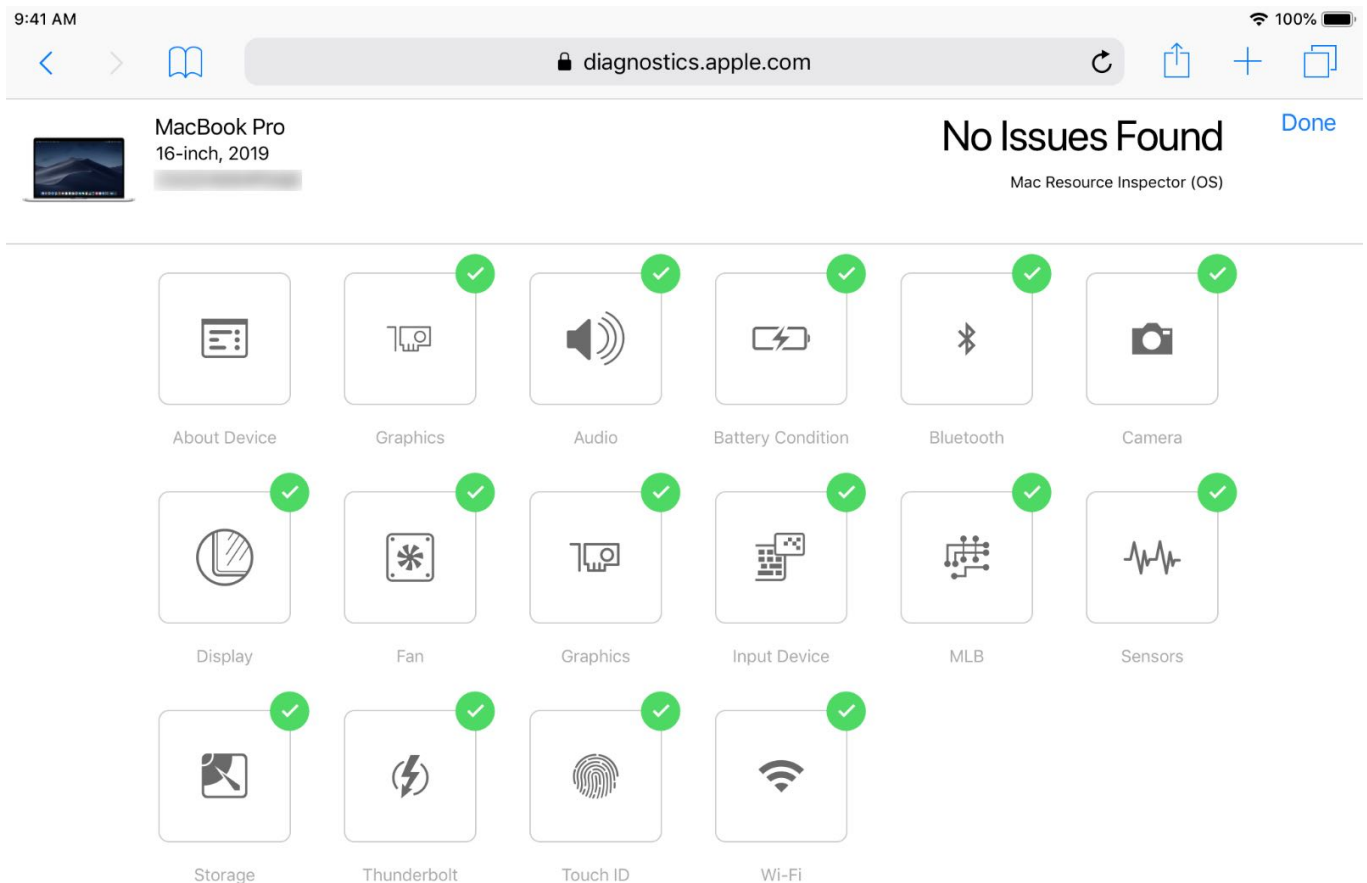
MRI (OS) is required instead of MRI (EFI) when the user reports any issue with a Mac notebook computer with the Apple T2 Security Chip that involves any T2-related components.

These tests are only available in MRI (OS):

- Ambient Light Sensor (ALS)
- Audio
- Bluetooth
- Camera
- Input device (built-in trackpad)
- Touch ID
- Lid Angle Sensor (LAS) presence for MacBook Pro (16-inch, 2019)

The MRI (OS) diagnostic suite also includes many of the same tests as the MRI (EFI) diagnostic suite, so in most cases you would not need to run both suites on Mac notebook computers with the Apple T2 Security Chip.

For example, the Battery, Fan, and Sensor tests exist in both MRI (EFI) and MRI (OS) because the other tests depend on these critical components. Graphics, Logic Board, Storage, Thunderbolt, and Wi-Fi tests take just a few seconds to run, so these are included in both MRI (EFI) and MRI (OS). These EFI and OS tests are functionally the same, so you do not need to run these tests in both EFI and OS.



**Note:** The screen shot above shows the available tests within MRI (OS) for MacBook Pro (16-inch, 2019); available tests for other models may vary.

**During triage and before repair:** MRI (OS) can be used to verify the presence of T2-related hardware components inside a Mac notebook computer with the Apple T2 Security Chip.

Run MRI (OS) to detect the presence of T2-related components for the following parts:

- MacBook Air (Retina, 13-inch, 2018):
  - Logic board
  - Touch ID board
- MacBook Air (Retina, 13-inch, 2019):
  - Display assembly
  - Logic board
  - Touch ID board
- MacBook Pro (13-inch, 2019, Two Thunderbolt 3 Ports), MacBook Pro (13-inch, 2018 and 2019, Four Thunderbolt 3 Ports), and MacBook Pro (15-inch, 2018 and 2019):
  - Display assembly
  - Logic board
  - Top case assembly
  - Touch ID board
- MacBook Pro (16-inch, 2019):
  - Display assembly
  - Logic board
  - Top case assembly
  - Touch ID board
  - Lid Angle Sensor (LAS)

**After reassembly:** For the parts listed above, you must also run the System Configuration repair completion suite.

**After repair:** For all hardware repairs, run Full System Diagnostic (OS) and Full System Diagnostic (EFI) suites to complete system testing of all hardware components after repair. The Full System Diagnostic suites also include all relevant tests

within MRI (OS), so you do not need to run MRI (OS) again.

### When to use the MRI (EFI) diagnostic suite

Some tests are only available in MRI (EFI) and are not available in MRI (OS).

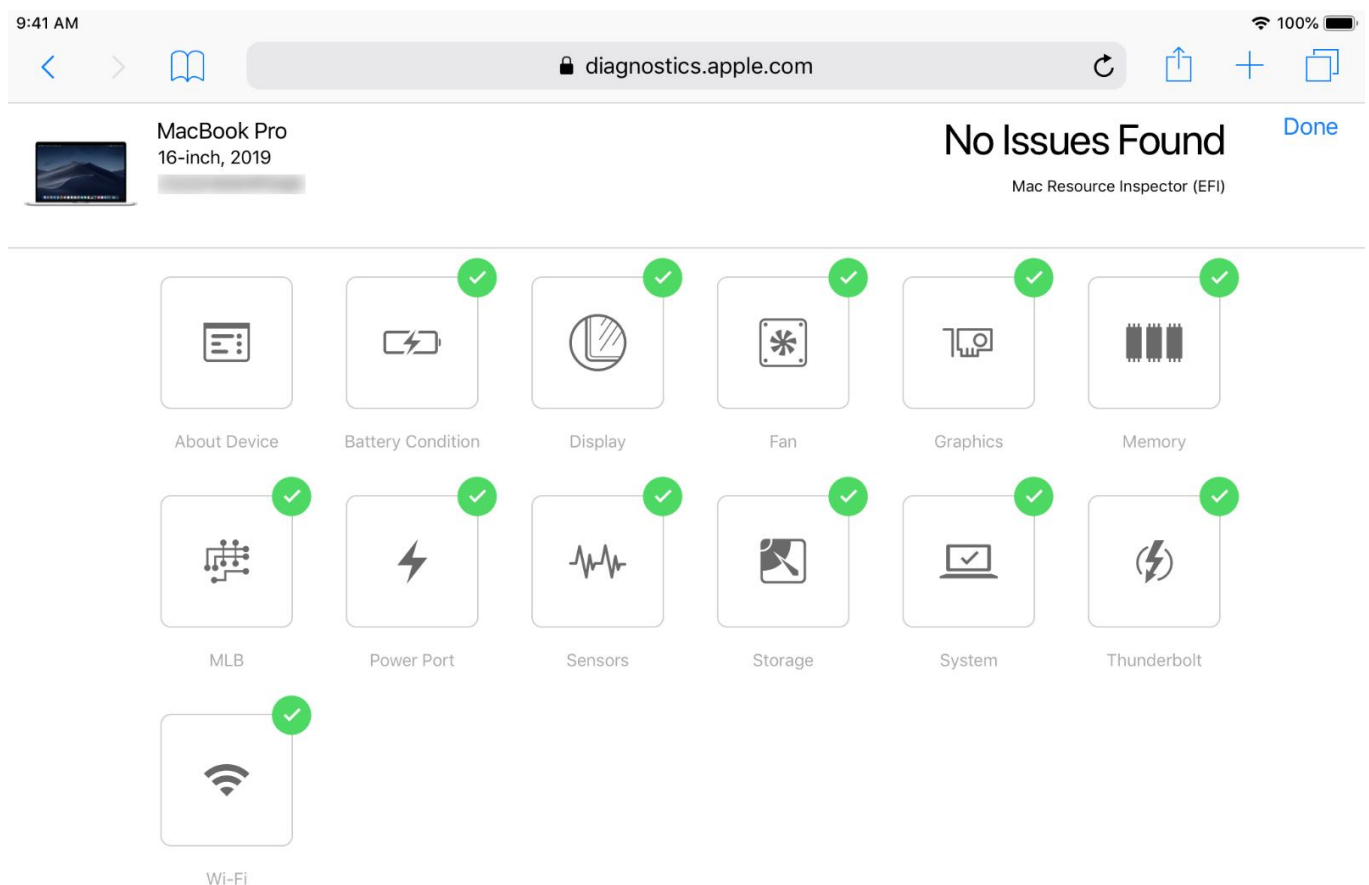
The following tests are only available in MRI (EFI):

- Memory
- Power Port
- System

The following tests are present in both MRI (EFI) and MRI (OS):

- About device
- Battery condition
- Display
- Fan
- Graphics
- MLB
- Sensors
- Storage
- Thunderbolt
- Wi-Fi

These tests are functionally the same, so you only need to run these tests from either MRI (EFI) or MRI (OS). You do not need to run these tests from both environments.



**Note:** The screen shot above shows the available tests within MRI (EFI) for MacBook Pro (16-inch, 2019); available tests for other models may vary.

MRI (EFI) is recommended instead of MRI (OS) in the following circumstances:

- When the user reports any issue that involves testing memory, the power port, or the presence of the recovery partition.



- When the user reports any issue with a Mac desktop or notebook computer other than a Mac notebook computer with the Apple T2 Security Chip.
- 

## **Troubleshooting**

If AST 2 MRI (OS) is not listed as an available diagnostic suite to run in your AST 2 Diagnostic Console, check the following:

- Verify that the UUT is a Mac notebook computer with the Apple T2 Security Chip.
- The AST 2 Diagnostic Console will only display applicable diagnostic suites for a UUT.

If AST 2 MRI (OS) is an available diagnostic suite to run on your AST 2 Diagnostic Console, but the UUT is having trouble connecting to AST 2, check the following:

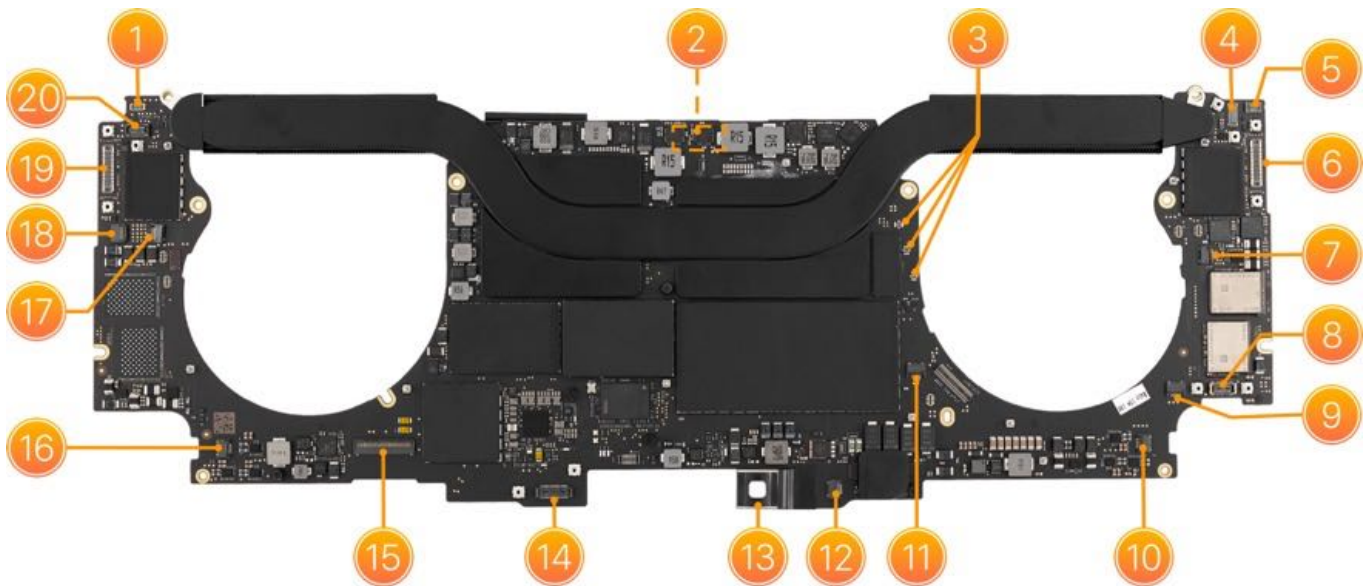
Verify that your service location's AST 2 Diagnostic Server Gateway Mac is running.

Verify that your service location's AST 2 Diagnostic Server Gateway Mac has the latest AST 2 diagnostic OS images and tools installed and configured.

Verify that the UUT is connected to the same LAN as your service location's AST 2 Diagnostic Gateway Server Mac.

# Functional Overview

## Functional Overview for MacBook Pro (16-inch, 2019)



### 1 = Touch ID Board

- Will not turn on from power button
- Will not authenticate using Touch ID

### 2 = Embedded DisplayPort (eDP) cable (also carries FaceTime HD camera & Ambient Light Sensor signals)

- No video, blurred, distorted, or monochrome video on display
- No display backlight
- Display does not dim in low light conditions
- Keyboard backlight cannot be enabled
- Camera does not function

### 3 = Wi-Fi + Bluetooth Antennas

- No/poor Wi-Fi reception
- Drops Wi-Fi connection
- Does not pair with Bluetooth devices
- Drops Bluetooth connection

### 4 = Touch Bar

- No touch response on Touch Bar

### 5 = Lid Angle Sensor (LAS)

- No sleep when display closed
- No video to internal display, but video to external display if one is connected (sensor stuck)

### 6 and 19 = I/O Board (2 USB-C ports each, on left and right side)

- No power
- No power LED
- No battery charge
- Power adapter issues
- USB connectivity issues
- USB power issues
- No video to external display
- No audio to external display speakers
- Thunderbolt device not found
- Thunderbolt controller not recognized
- Thunderbolt driver issue
- Thunderbolt power issues

### 7 = Tri-Mic (part of top case)

- No microphone audio input (with Internal Microphone selected in Sound Input Preferences)
- Distorted microphone audio input

#### **8 = Touch Bar Display**

- No video, blurred, distorted, or monochrome video on Touch Bar display

#### **9 = Left Keyboard Backlight**

- No keyboard backlight on left half of keys

#### **10 = Left Speaker**

- No audio from left speaker
- Distorted audio from left speaker

#### **11 = Left Fan**

- Fan not running
- Intermittent shutdown

#### **12 = Battery (BMU signal flex)**

- No power
- Not charging (verify with correct model of power adapter)
- X symbol for battery in menu bar

#### **13 = Battery (BMU power flex and BMU interconnect screw)**

- No power
- Not charging (verify with correct model of power adapter)
- X symbol for battery in menu bar

#### **14 = Trackpad**

- No Multi-Touch or cursor movement from built-in trackpad
- No click action from built-in trackpad

#### **15 = Keyboard**

- Non-responsive keys

#### **16 = Right Speaker**

- No audio from right speaker
- Distorted audio from right speaker

#### **17 = Right Fan**

- Fan not running
- Intermittent shutdown

#### **18 = Right Keyboard Backlight**

- No keyboard backlight on right half of keys

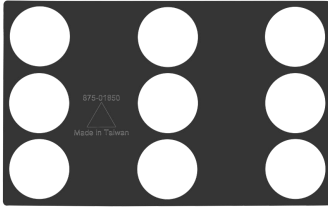
#### **20 = Audio Jack**

- No external audio input
- No headphone audio output
- No headset controls or mic input

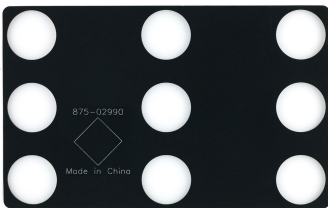
# Trackpad Calibration Check

## Required tools:

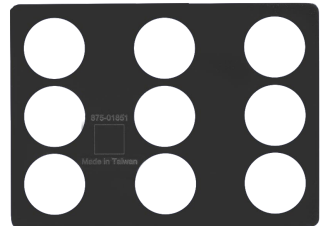
- Weight Placement Rubber Template (923-00555)
  - MacBook (Retina, 12-inch, Early 2015, Early 2016, and 2017)



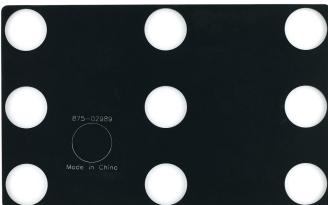
- Weight Placement Rubber Template (923-01316)
  - MacBook Pro (13-inch, 2016, 2017, and 2019, Two Thunderbolt 3 Ports)
  - MacBook Pro (13-inch, 2016, 2017, 2018, 2019, Four Thunderbolt 3 Ports)



- Weight Placement Rubber Template (923-00599)
  - MacBook Pro (Retina, 13-inch, Early 2015) and (Retina, 15-inch, Mid 2015)



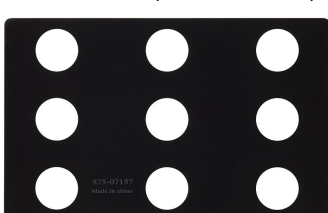
- Weight Placement Rubber Template (923-01317)
  - MacBook Pro (15-inch, 2016, 2017, 2018, 2019)



- Weight Placement Rubber Template (923-02462)
  - MacBook Air (Retina, 13-inch, 2018 and 2019)



- Weight Placement Rubber Template (923-03890)
  - MacBook Pro (16-inch, 2019)



**Note:** Weight Placement Rubber Templates come in a pack of three. If the edges start to curl, it is necessary to order a new pack.

- 200 g and 800 g weights (923-00462)



**Steps:**

To verify that the trackpad is responding as expected, run the Trackpad Calibration Check after every repair, including when only the bottom case has been removed and reassembled.

**Note:** It is recommended to also run the Trackpad Response test after a top case with keyboard has been replaced, or if the user is having issues related to trackpad functionality.

1. Place the Weight Placement Rubber Template on the trackpad before launching the test in AST 2. This establishes the correct baseline for the weights.

**Important:** Do not tape the Weight Placement Rubber Template to the top case. Tape may cause inaccurate test results.



2. Launch AST 2. In Diagnostic Console, select Trackpad Calibration Check from the list of diagnostic suites.



**Caution:** The Trackpad Calibration Check is very sensitive to external disturbances. Run the test on a flat surface. Do not run the diagnostic on a bench where other technicians are working. To avoid interfering with the results, be sure to place weights down gently on a separate surface while running the diagnostic. If the computer is bumped or jostled while the diagnostic is running, restart the test.

Diagnostic Console

John Doe |

< Diagnostic Results

Diagnostic Suites

TRIAGE

Trackpad Response

Assists in verifying functionality of trackpad.

3 minutes

>

REPAIR

Trackpad Calibration Check

Verifies calibration of the trackpad actuator and force sensor.

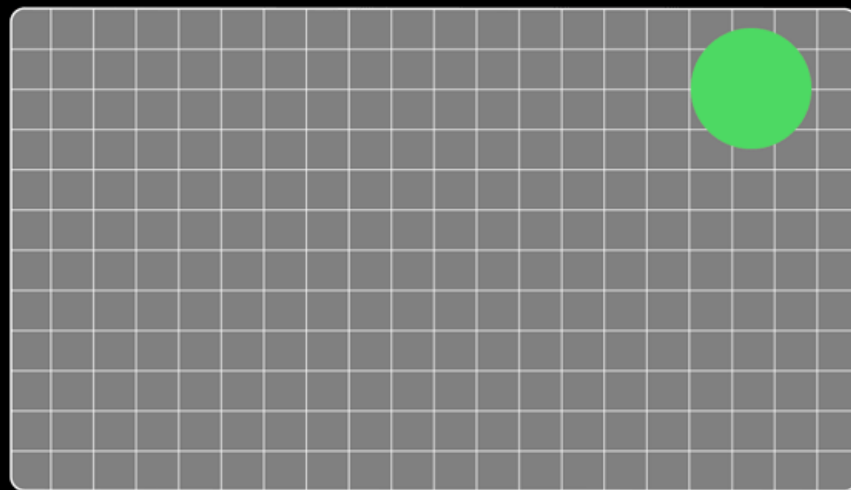
3 minutes

>

3. The diagnostic suite consists of several stages. The first stage of the suite is the Force Check, which is interactive and requires placing the 200g and 800g weights as indicated. The blue dot will indicate where on the trackpad to place each weight. The text at the bottom of the screen will indicate which weight to use at each step. The dot will turn green when it is time to lift the weight from the trackpad.

Test Instruction

Place the 200g weight on the indicated area and press any key.

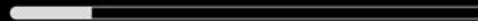


### Test Instruction

Remove the weight from the indicated area and press any key.

4. The next stage is the Actuator Check. During this stage, the trackpad will make clicking sounds while the actuator is tested. If any issues with the actuator are identified, the test may need to proceed to the next stage, which is the Actuator Calibration. The trackpad will continue to make clicking sounds while the actuator is calibrated. During this process, the unit under test (UUT) will display the screen shown below.

Checking your Mac...



Restart



Shut Down

5. If no issues are found, the screen will look like the image below. The trackpad calibration is verified.



About Device



Input Device

- ✓ Actuator Calibration
- ✓ Critical Error Test
- ✓ Open Test
- ✓ Force Check

6. If issues were found in the Actuator Check, the Actuator Calibration, or the Force Check, the screen will look like the image below and the suite should be run again. If the computer fails a second time, a top case with keyboard replacement is recommended.



MacBook Pro

C0282-69-000-000

# Issues Found

Trackpad Calibration Check

October 20th, 2016 2:19 PM



About Device



Input Device

- ✓ Actuator Calibration
- ✓ Critical Error Test
- ✓ Open Test
- ! Force Check

# System Configuration for Macs with the Apple T2 Security Chip

## System Configuration for Macs with the Apple T2 Security Chip

For Macs with the Apple T2 Security Chip, the repair process is not complete for the replacement of certain parts until the AST 2 System Configuration suite has been run successfully. This step is required for Apple certified technicians to ensure repair quality and compliance with regional communications regulations.

Completion of this process ensures the security features of the Apple T2 Security Chip function properly, enabling on-the-fly hardware encryption, biometric authentication, and secure boot protection.

- The System Configuration suite executes a variety of steps depending on the parts used in the repair. A series of presence tests are conducted to verify components related to the Apple T2 Security Chip have been reconnected correctly. This includes the Touch ID sensor, ambient light sensor, Touch Bar, and camera.
- Then the Touch ID sensor and Touch Bar are paired to the logic board and their calibration values are updated to optimize their performance. For a logic board replacement, the system serial number is written to the new logic board, the logic board serial number is reported to Apple to enable iCloud services including FaceTime, Messages, and Apple Pay, and the wireless region is assigned.

**Note:** To ensure compliance with regional communications regulations, the system will boot to a flashing prohibitory sign until the wireless region has been assigned.

- The final step for all repair types is to update the Apple T2 Security Chip firmware to the most current version.
- The exact steps executed are visible in the AST 2 Diagnostic Console by selecting the suite in Diagnostics Results and clicking Details.

**Important:** If logic board or flash storage has been replaced, make sure the customer's current data is backed up before starting this procedure. Neither data nor data recovery will be available once System Configuration has been performed.

This article contains:

- [When System Configuration is Required](#)
- [Tools](#)
- [Before Starting an AST 2 Session](#)
- [Steps](#)
- [Troubleshooting Tips](#)

## When System Configuration is Required

### Perform System Configuration after these part replacements:

Computer Model	Logic Board	Top Case	Display	Touch ID	Flash Storage	Lid Angle Sensor (LAS)
iMac Pro (2017)	•				•	
Mac mini (2018)	•					
MacBook Air (Retina, 13-inch, 2018)	•			•		
MacBook Air (Retina, 13-inch, 2019)	•		•	•		
MacBook Pro (13-inch, 2019, Two Thunderbolt 3 Ports)	•	•	•	•		
MacBook Pro (13-inch, 2018, Four Thunderbolt 3 Ports)	•	•	•	•		
MacBook Pro (13-inch, 2019, Four Thunderbolt 3 Ports)	•	•	•	•		
MacBook Pro (15-inch, 2018)	•	•	•	•		
MacBook Pro (15-inch, 2019)	•	•	•	•		
MacBook Pro (16-inch, 2019)	•	•	•	•		•
Mac Pro (2019) and Mac Pro (Rack, 2019)	•				•	

## Tools

- Power cord
- USB-C to USB-C Charge Cable included with portables (661-06670) or USB-A to USB-C Apple TV Restore Cable

(923-00504)

**Note:** Thunderbolt 3 cables are not supported.



- A host computer with:
  - macOS Catalina 10.15 or later
  - [Mac Configuration Utility \(MCU\)](#) installedFor information on how to set up the host computer  
**Note:** Do not use third-party web browsers on an MCU host computer. Third-party web browsers may impact the performance of System Configuration when MCU and a third-party web browser are open at the same time. Remove any installed third-party browsers and then restart the MCU host computer.  
Internet connection
- 

### Before Starting an AST 2 Session

- Be sure parts have been added to the repair.
- Be sure known good board (KGB) and known bad board (KBB) serial numbers have been added to the repair.  
**Important:** If the serial numbers are not entered and saved in the repair system correctly, the System Configuration suite will not become available.
- Be sure the repair has been saved.

### Note:

- The logic board serial number must be entered in upper case characters. To ensure accuracy, it is recommended to scan the QR code on the logic board.
- Close the display after putting the computer into DFU mode.

### Steps

1. Start a diagnostic session on the AST 2 [Diagnostic Console](#).
2. Connect the customer's computer to the host computer. If the host computer does not have a USB-C port, use a USB-C to USB-A cable. It is important to connect the USB-C cable to the correct port on the customer's computer or the process will not run.

**Important:** Be sure both the customer's computer and the host computer are connected to power.

**Notebooks:** Use only the USB-C port closest to the caps lock key.





**iMac Pro:** Use only the USB-C port closest to the Ethernet port.



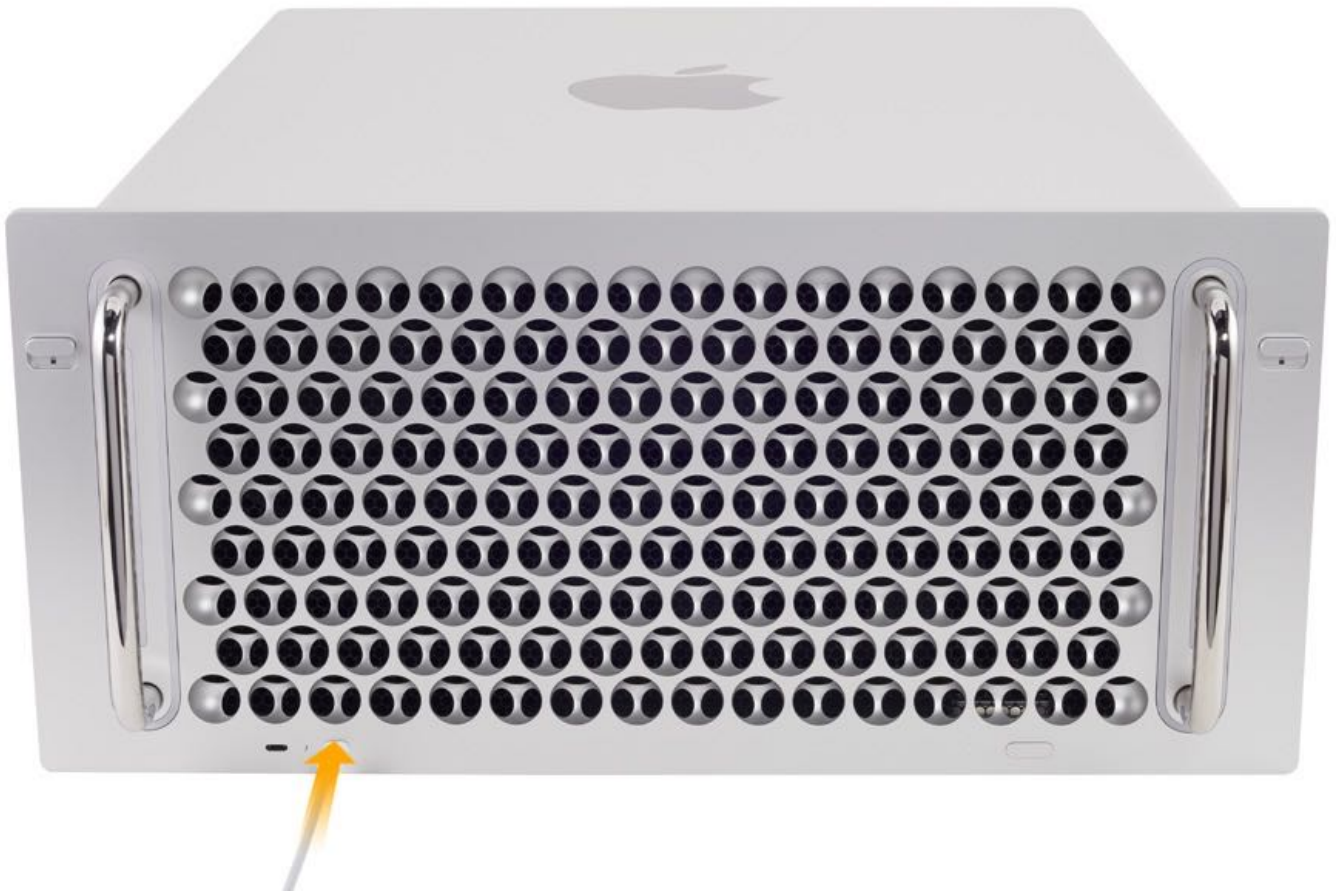
**Mac mini (2018):** Use only the USB-C port closest to the HDMI port.



**Mac Pro (2019):** Use only the outer USB-C port closest to the housing edge.



**Mac Pro (Rack, 2019):** Use only the USB-C port closest to the power button.



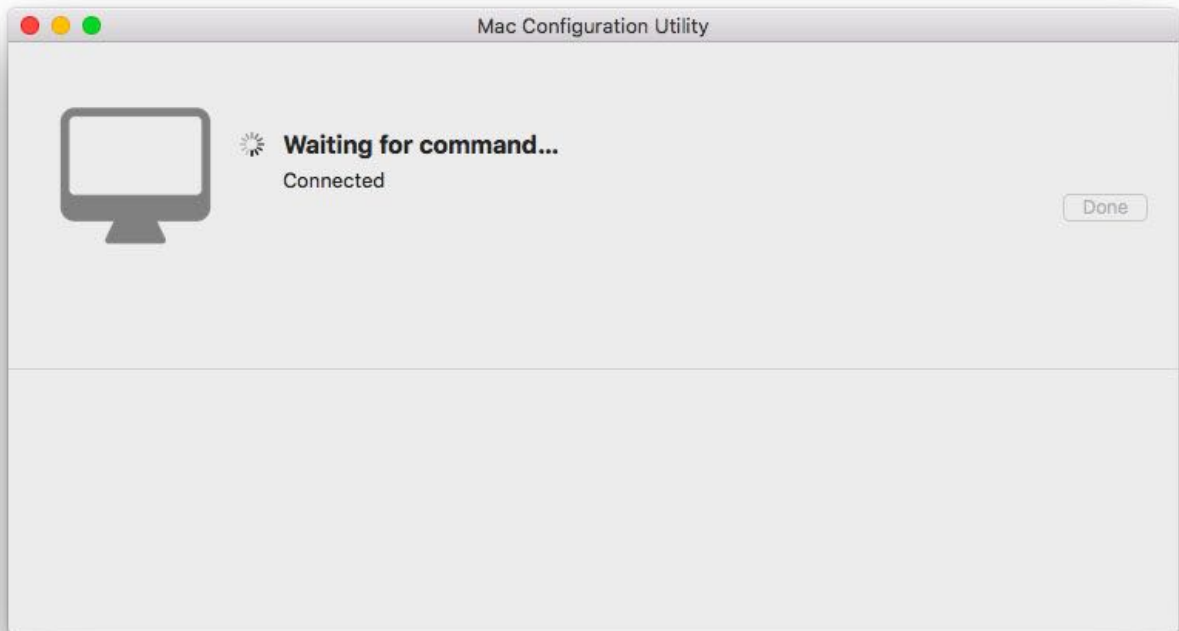
3. Verify that the host computer is turned on, connected to power, and connected to the Internet.

4. Start up the customer's computer in Device Firmware Update (DFU) mode.

- **For desktops:** Press and hold the power button while connecting the power cord. Continue to hold the power button until you see the prompt appear in Mac Configuration Utility, which may take up to 10 seconds.
- **For notebooks:** Press and hold the power button, then press and hold Left Control-Left Option-Right Shift until you see the prompt appear in Mac Configuration Utility, which may take up to 10 seconds.

**Important:** For display repair and LAS repair in MacBook Pro (16-inch, 2019) only, look for a prompt instructing you to close the display. If the display is not closed when prompted, the suite will not run properly and the LAS will need to be replaced.

5. If DFU has been performed correctly, MCU will automatically launch and a dialog box will appear on the host computer screen.



**Note:** If a diagnostic session has not been created yet, this message will appear:

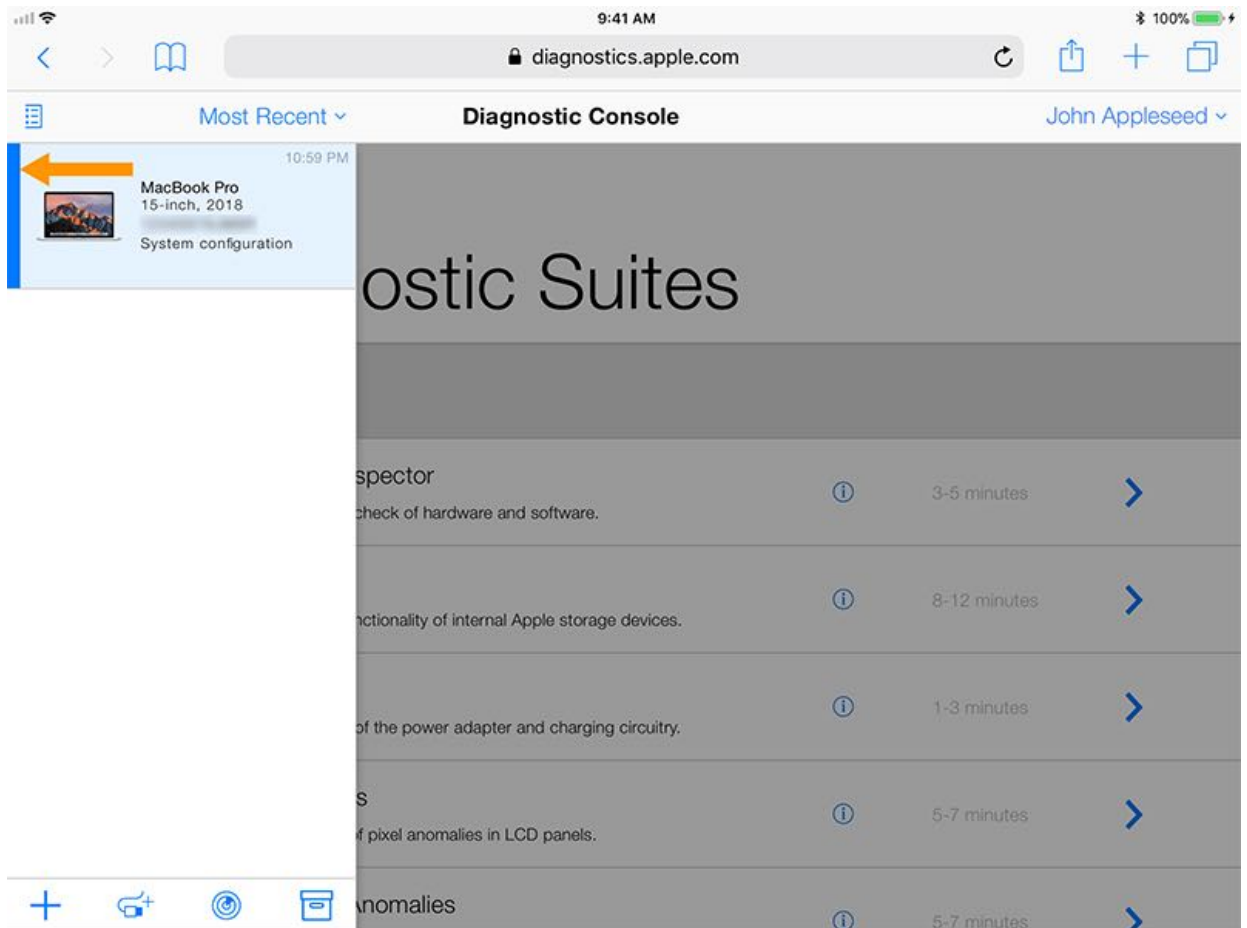


6. Confirm that the customer's computer appears online in the Diagnostic Console. You will see a blue bar next to the name and serial of the customer's computer.

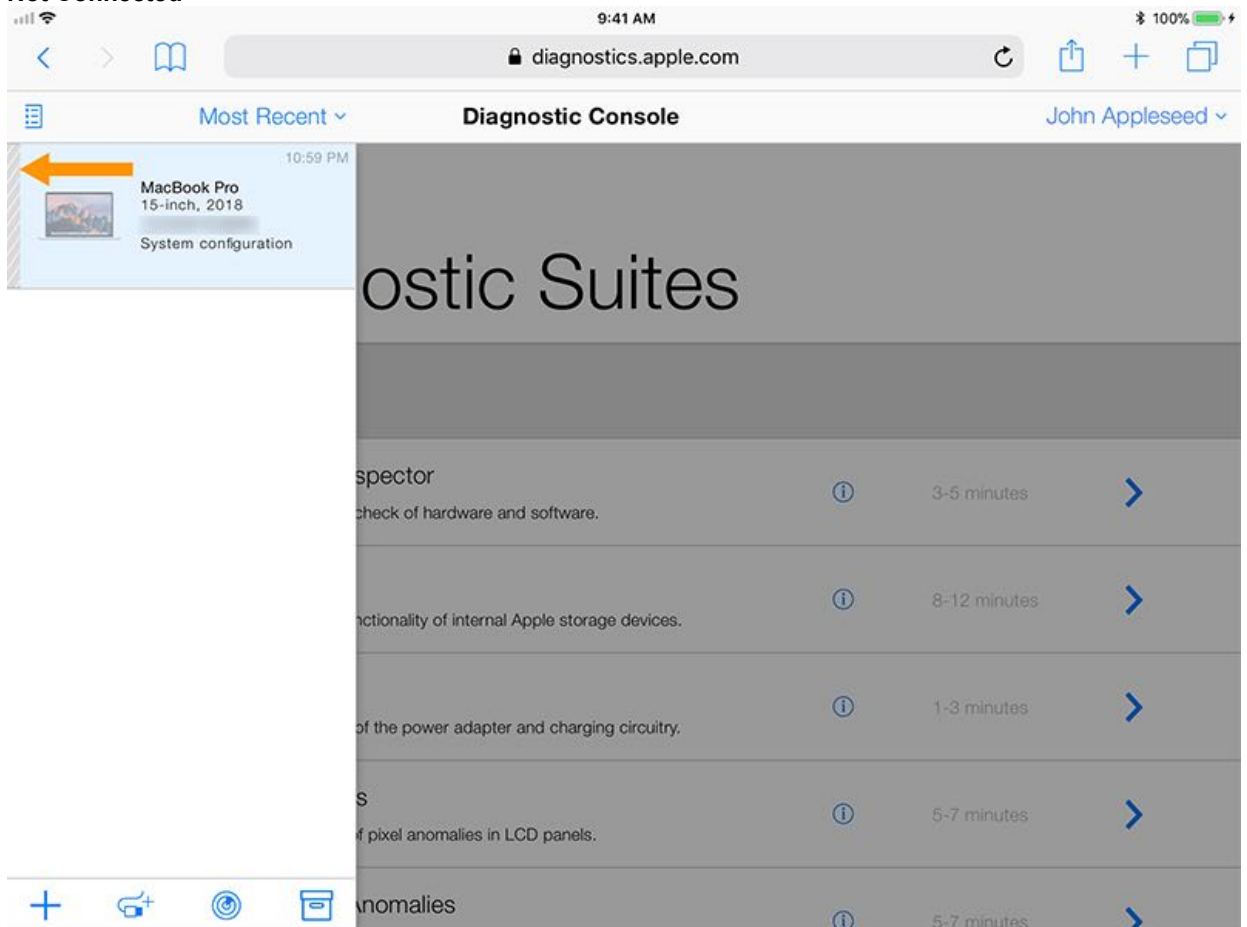
**Note:** If the computer does not appear, the serial number may have been entered incorrectly or the repair was not saved correctly. Both the system serial number and the part serial numbers must be accurate to continue.

- **Connected**





• **Not Connected**

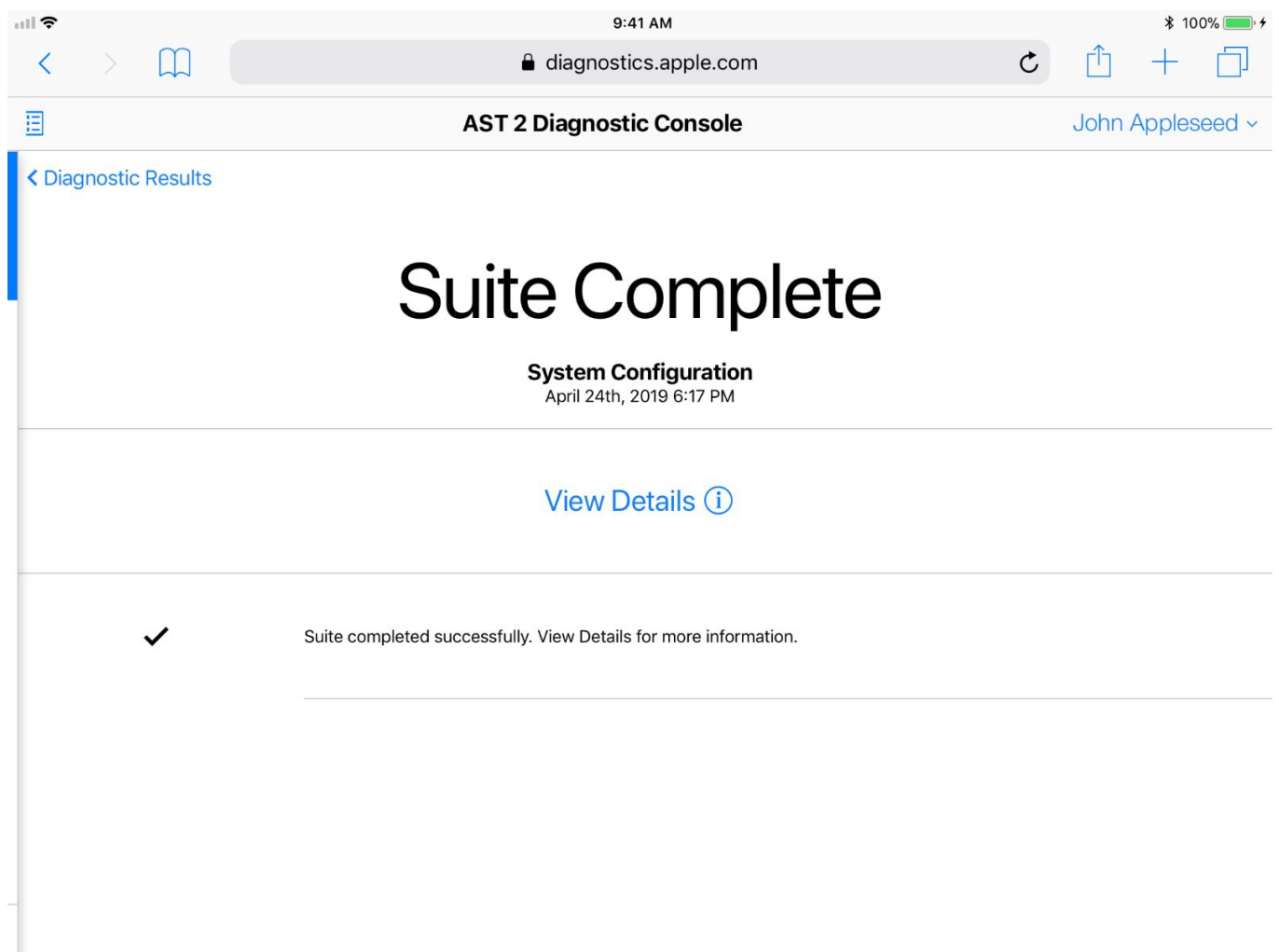


7. Choose the System Configuration suite from the Diagnostic Console.



8. Toward the end of the process, the Apple logo and a progress bar will appear.

9. The customer's computer will restart and test results will appear in the Diagnostic Console of AST 2.



**Note:**

- While the process is running, the customer's display remains blank most of this time.
- Firmware restoration will take about two minutes.

10. If no issues are found:

- Restart the customer's computer and run MRI as well as all applicable diagnostics to complete the repair.
- For notebooks, Trackpad Calibration Check suite must be run any time the computer is opened.

**Note:** For iMac Pro, macOS needs to be reinstalled. Shut down the desktop and then restart in recovery mode to install the macOS from Internet Recovery.

11. If issues are found and a diagnostic test fails:

- Follow the instructions on the Diagnostic Console.
- Escalate to CSS.

## **Troubleshooting Tips**

### **If the session does not activate (the gray bar does not turn blue):**

1. Verify that the host machine is connected to the internet.
2. Verify the customer's computer is connected to power.
3. Verify the customer's computer is in DFU mode.
4. Verify the correct port on the customer's computer is being used.
5. Verify the correct cable is being used.

**Note:** Do not use USB-C to USB-A cable (923-00504) combined with USB-C to USB Adapter (MJ1M2AM/A).

6. Verify that the serial number of the customer's computer was entered correctly.
7. Verify the parts have been correctly added to the repair.

### **If the System Configuration suite is not available:**

1. Verify parts have been added to the repair.
2. Verify the KBB and KGB serial numbers are correct.
3. Verify the repair has been saved.
4. Archive and recreate the diagnostic session.
5. Restart the host computer.
6. Open the device and confirm that all internal components were properly installed and all flex cables are securely connected.
7. If it has been more than 14 days since parts were added to the repair, escalate to CSS.

### **If the session is interrupted (the blue bar turns to gray):**

1. Archive and recreate the diagnostic session.
2. Check the network connection.
3. Restart the host computer.
4. Verify the host machine is not sleeping.
5. Open the device and confirm that all internal components were properly installed and all flex cables are securely connected.

# Tools and Fixtures

## Tools and Fixtures for MacBook Pro (16-inch, 2019)

The following tools are required:

- Battery cover (923-03891)
- Clean, soft, lint-free cloth
- ESD-safe workstation, including an ESD mat and wrist or heel strap
- ESD bags (for storing ESD-sensitive parts while removed from the unit)
- ESD-safe tweezers
- Antenna tool (923-01322)
- Suction cup (922-8252)
- Pentalobe screwdriver (923-0731)
- Torque driver (blue), 0.65 kg-fcm (923-0448)
- 1IPR security bit (923-0247) for use with the Torque driver (923-0448)
- Torx T3 screwdriver (magnetized)
- Torx T5 screwdriver (magnetized)
- Torx T8 screwdriver (magnetized)
- Black stick or other nonconductive nylon or plastic flat-blade tool (922-5065)
- Thermal grease syringe (922-7144)
- Isopropyl alcohol (IPA) wipe (included with heat sink and logic board)
- Magnifying glass (for reading serial number)
- Keycap lever (923-01803)
- Keycap tool kit (076-00457) includes: Keycap lever and precut VHB adhesive strips

**Caution:** To prevent scratches or other cosmetic damage to the computer housing, use a soft cloth as a protective layer when removing and installing the external screws.

### Battery Cover (923-03891)



### Bottom Case Fixture

- Bottom case removal/install fixture kit (076-00290), which includes:
  - Bottom case fixture
  - Quick grip clamps (2), also available separately (923-01369)
  - Nonslip gloves, small (pair), also available separately (923-01371)
  - Nonslip gloves, extra large (pair), also available separately (923-01370)



- Nonslip gloves, medium/large (pair), only available separately (923-01368), not part of the kit
- Bottom Case Extension Kit (076-00459)

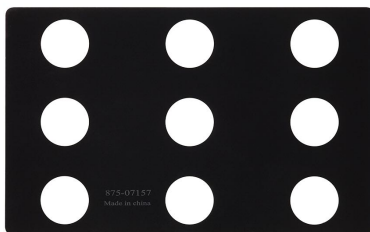


## Trackpad Tools

- Trackpad calibration weights, 200 g and 800 g (923-00462)



- Weight Placement Rubber Template (923-03890)



## Touch ID Tools

- Touch ID alignment tool kit (923-03032)



# Take Apart Procedure Notes

## Reassembly Steps

When no replacement steps are listed, replace parts in exact reverse order of Removal procedure.

## Note About Images in This Guide

In some cases a pre-production model may have been used to document the procedures in this guide. Although there may be small differences in appearance between the image pictured and the computer you are servicing, the procedures are the same unless noted.

## Screw Sizes

All screw sizes shown are approximate and represent the total length of the screw.





# Bottom Case

## First Steps



### Warning:

- To avoid damaging parts, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw before you begin a repair.
- Do not apply external power while the computer is under repair.

### Important:

- Only Apple-certified technicians should perform this procedure. Follow ESD guidelines.
- 
- 

### Before you begin:

- Shut down the computer.
- Unplug all cables.
- Put on an ESD wrist strap.
- Place the computer facedown on a clean, flat surface.



## Tools

- ESD wrist strap
- Pentalobe screwdriver (923-0731)
- Battery cover:
  - 923-01318 for MacBook Pro (13-inch, 2016, 2017, and 2019, Two Thunderbolt 3 Ports)
  - 923-01319 for MacBook Pro (13-inch, 2016 and 2017, Four Thunderbolt 3 Ports)

- 923-02533 for MacBook Pro (13-inch, 2018 and 2019, Four Thunderbolt 3 Ports)
- 923-01320 for MacBook Pro (15-inch, 2016 and 2017)
- 923-02532 for MacBook Pro (15-inch, 2018 and 2019)
- 923-03891 for MacBook Pro (16-inch, 2019)
- Bottom case removal kit (076-00290)
- For MacBook Pro (16-inch, 2019): Bottom case extension kit (076-00459) (not shown)
- Fine-tip permanent marker
- Suction cup (922-8252)
- Clean, soft, lint-free cloth (not shown)

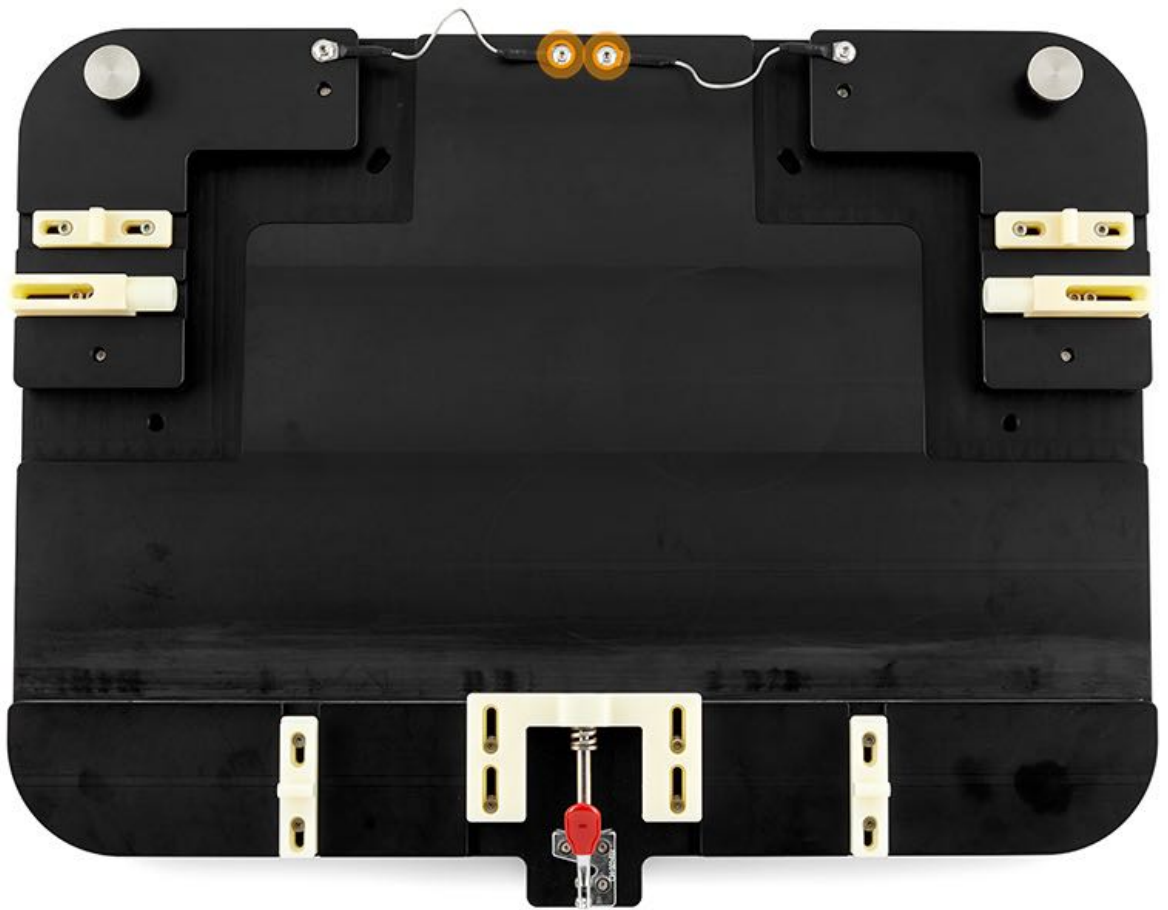


## Steps For Removal

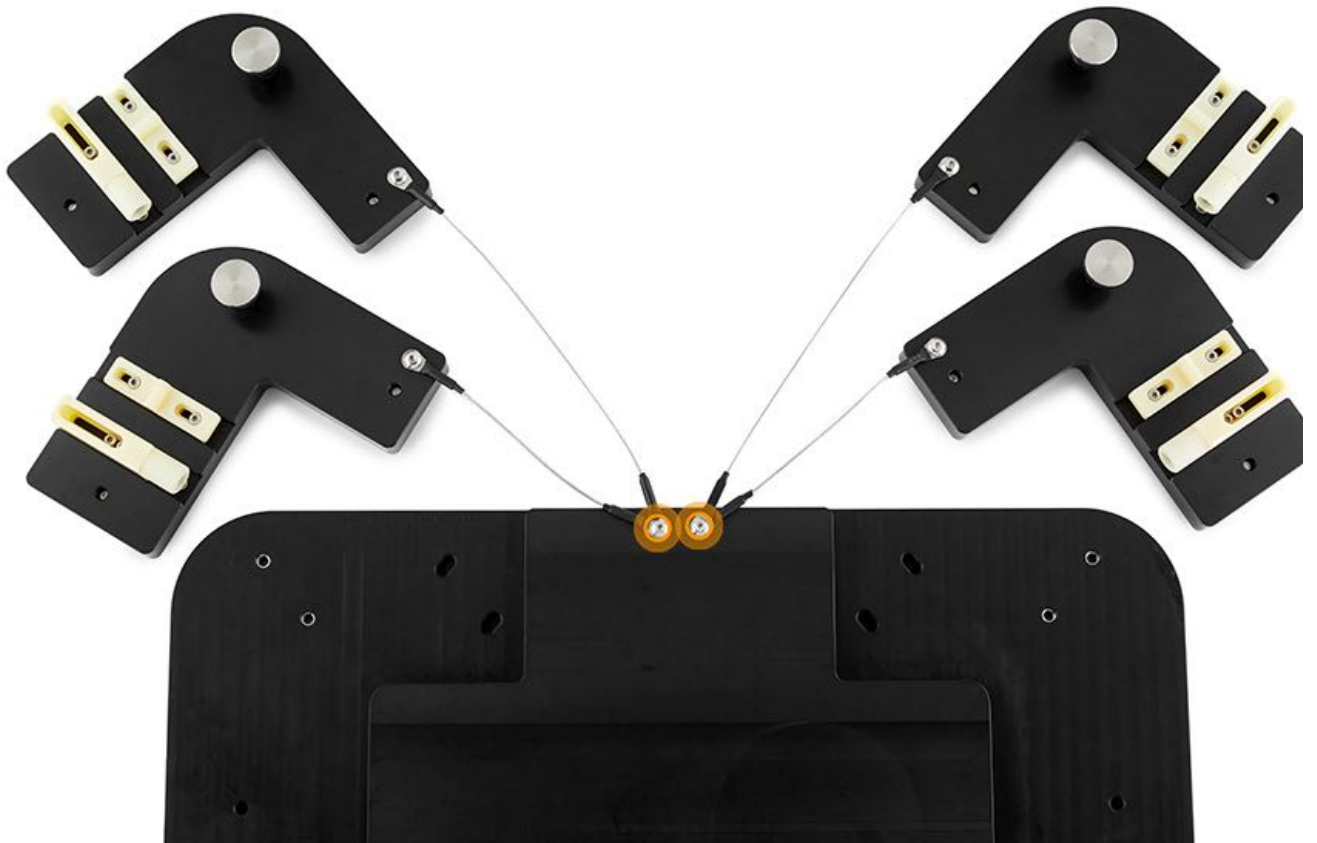
### For MacBook Pro (16-inch, 2019) only:

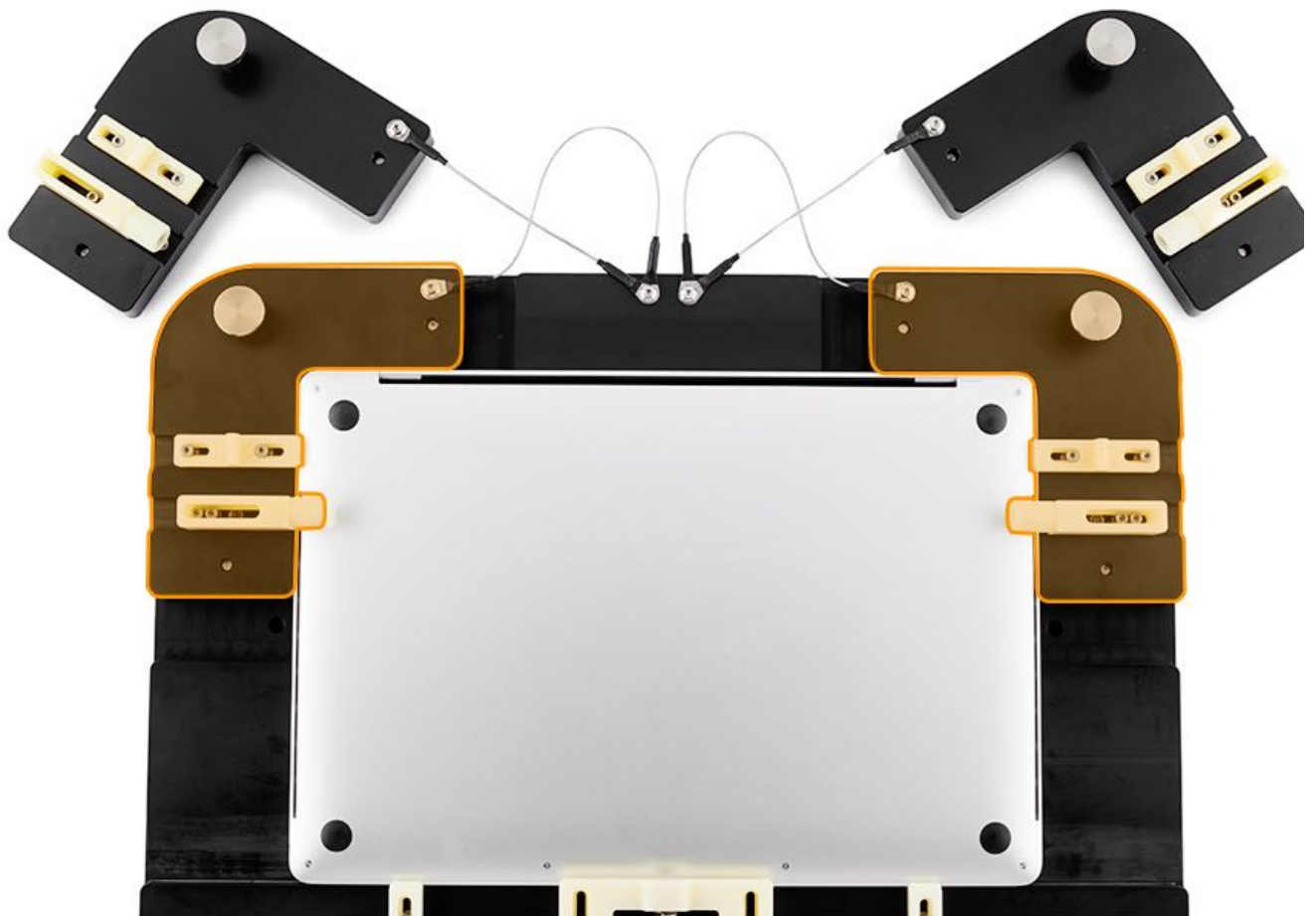
The MacBook Pro (16-inch, 2019) requires new corners to be attached to the bottom case removal kit. These corners can be found in the bottom case removal extension kit (076-00459). You only need to install the new corners to the bottom case removal kit once. **Note:** There is a plus sign on the corners for the MacBook Pro (16-inch, 2019).

- Use the hex driver included in the kit to remove the screws attaching the corners to the tray.



- Attach the new corners and reinstall the screws. Use the new corners when servicing the MacBook Pro (16-inch, 2019).





1. Remove the six Pentalobe screws in any sequence.

**MacBook Pro (16-inch, 2019)**



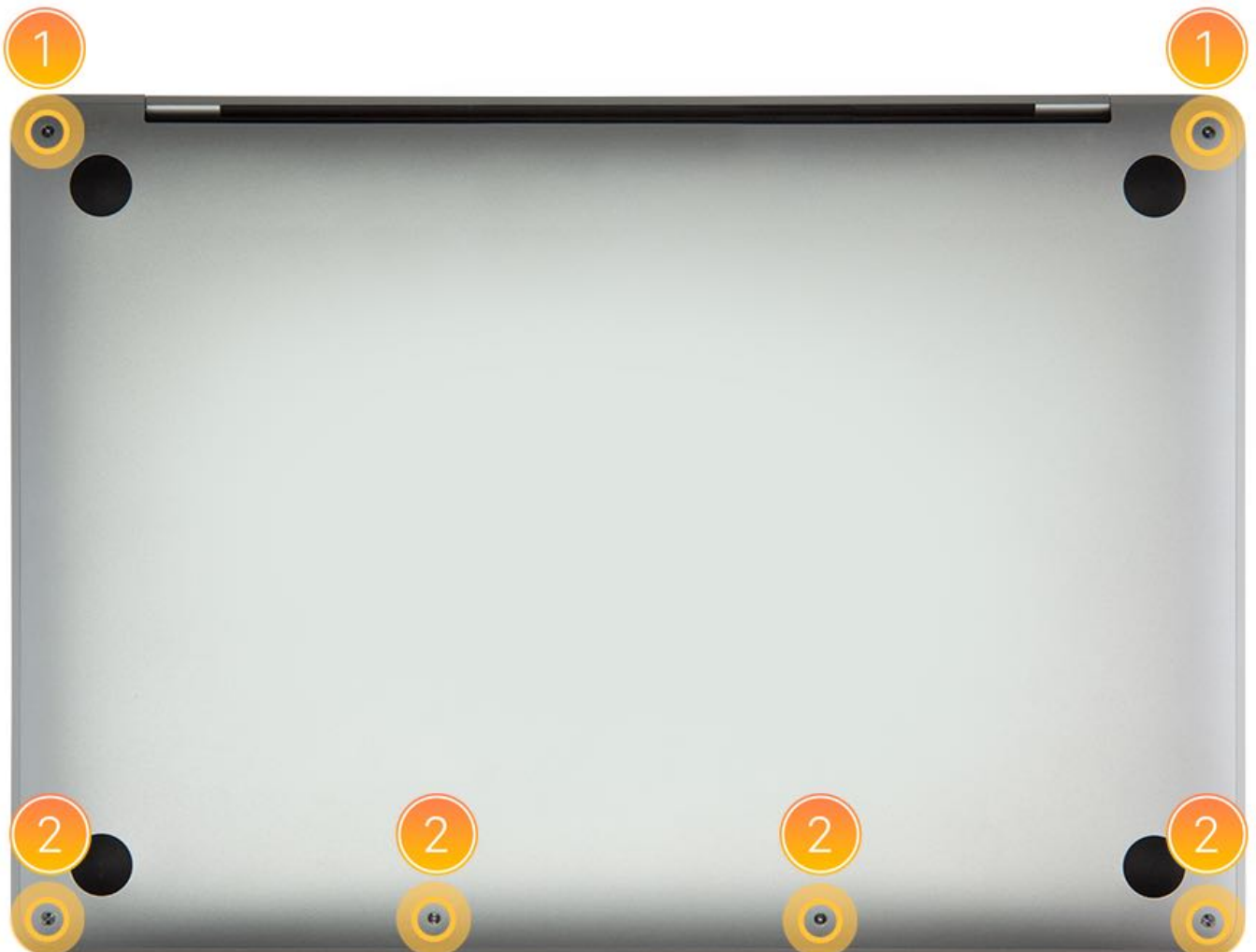
MacBook Pro (16-inch, 2019)		
Color	Screw #1	Screw #2
Space Gray	923-03955 	923-03963 
Silver	923-03964 	923-03965 

**MacBook Pro (13-inch, 2016, 2017, and 2019, Two Thunderbolt 3 Ports)**



MacBook Pro (13-inch, 2016 and 2017, Two Thunderbolt 3 Ports)			
Color	Screw #1	Screw #2	Screw #3
Space Gray	923-01299 	923-01097 	923-01095 
Silver	923-01099 	923-01100 	923-01098 
MacBook Pro (13-inch, 2019, Two Thunderbolt 3 Ports)			
Color	Screw #1	Screw #2	Screw #3
Space Gray	923-03198 	923-03199 	923-03200 
Silver	923-03201 	923-03202 	923-03203 

**MacBook Pro (13-inch, 2016, 2017, 2018, 2019, Four Thunderbolt 3 Ports) and MacBook Pro (15-inch, 2016, 2017, 2018, 2019)**





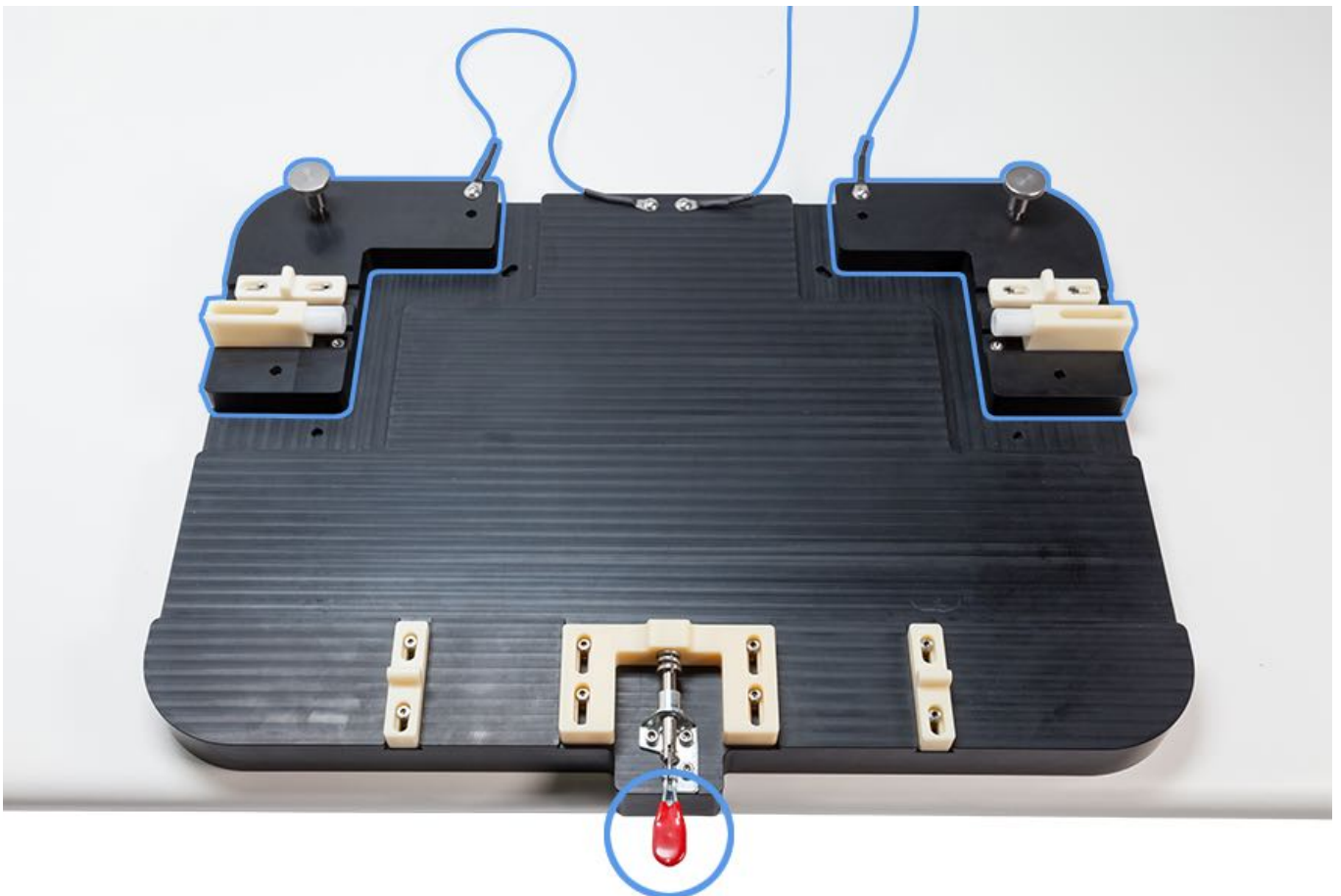
**MacBook Pro (13-inch, 2016, 2017, 2018, 2019, Four Thunderbolt 3 Ports)**

Color	Screw #1	Screw #2
Space Gray	923-01096 	923-01413 
Silver	923-01415 	923-01431 

**MacBook Pro (15-inch, 2016, 2017, 2018, 2019)**

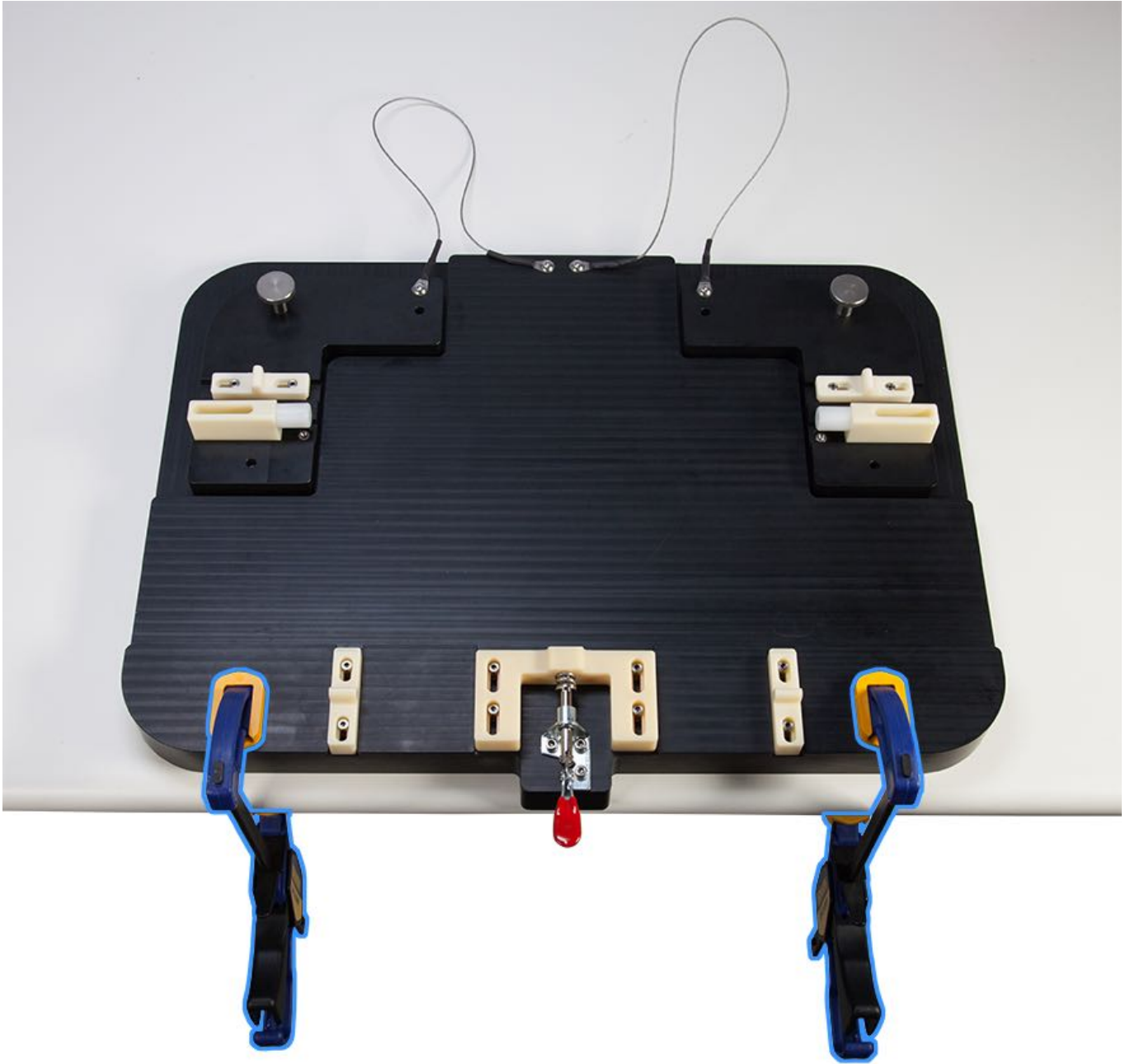
Color	Screw #1	Screw #2
Space Gray	923-01514 	923-01513 
Silver	923-01517 	923-01516 

2. Position the bottom case fixture so that the red lever is at the bottom and the tethered corner braces are at the top.

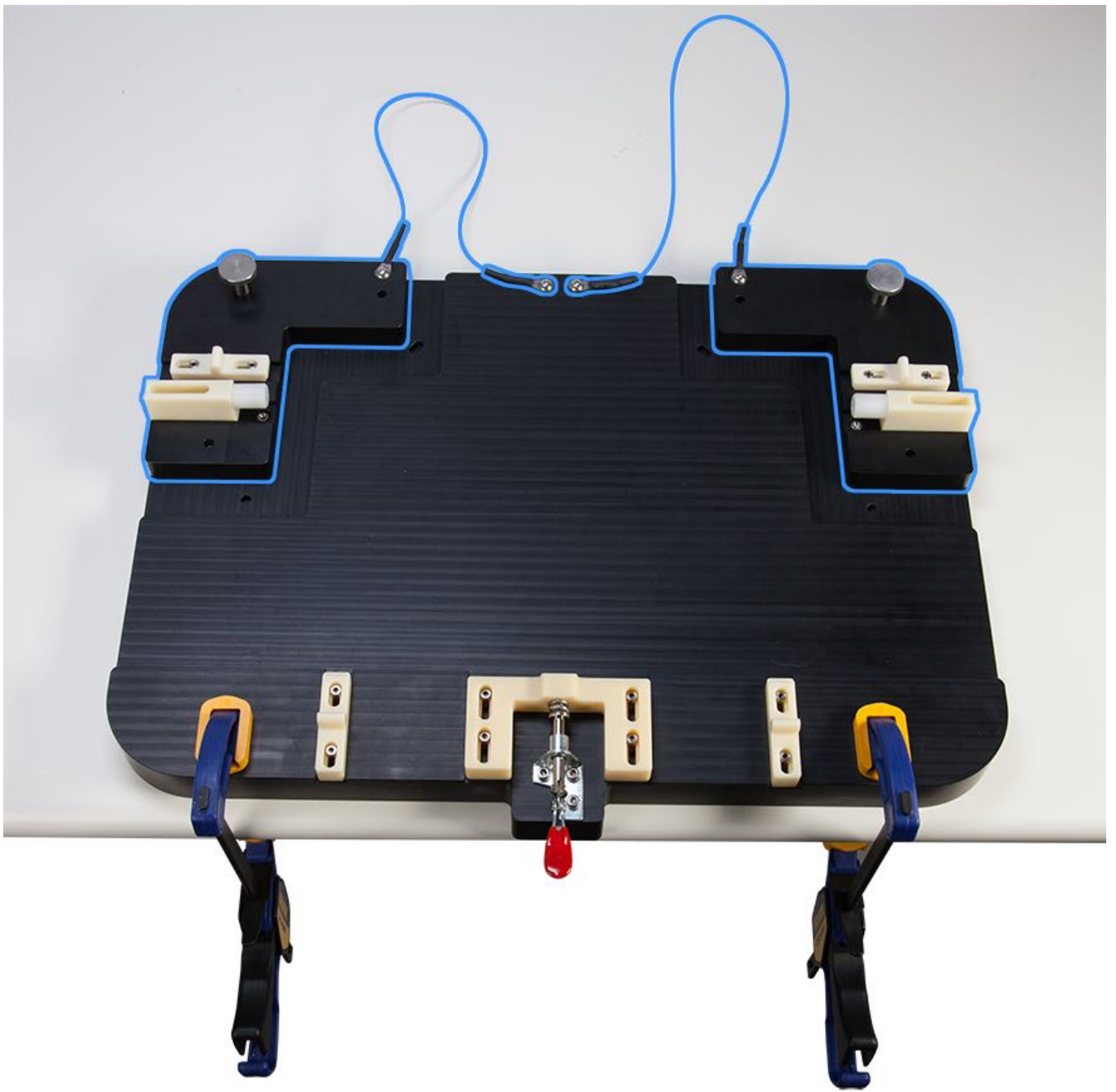


3. Use two clamps to secure the bottom case fixture to the table. Squeeze the clamp handles to tighten them. Make sure that

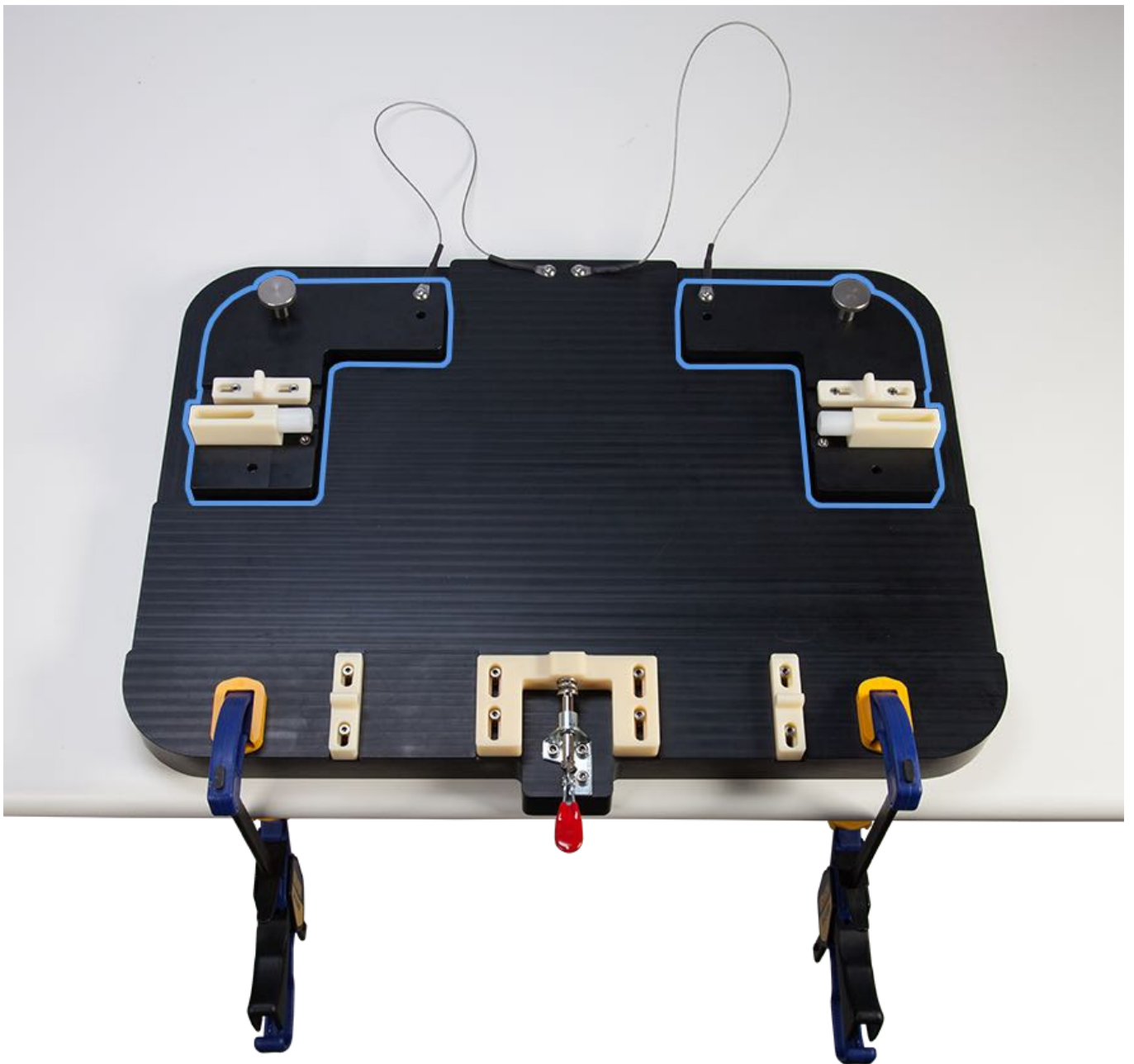
the sliding bars of the clamps are below the table.



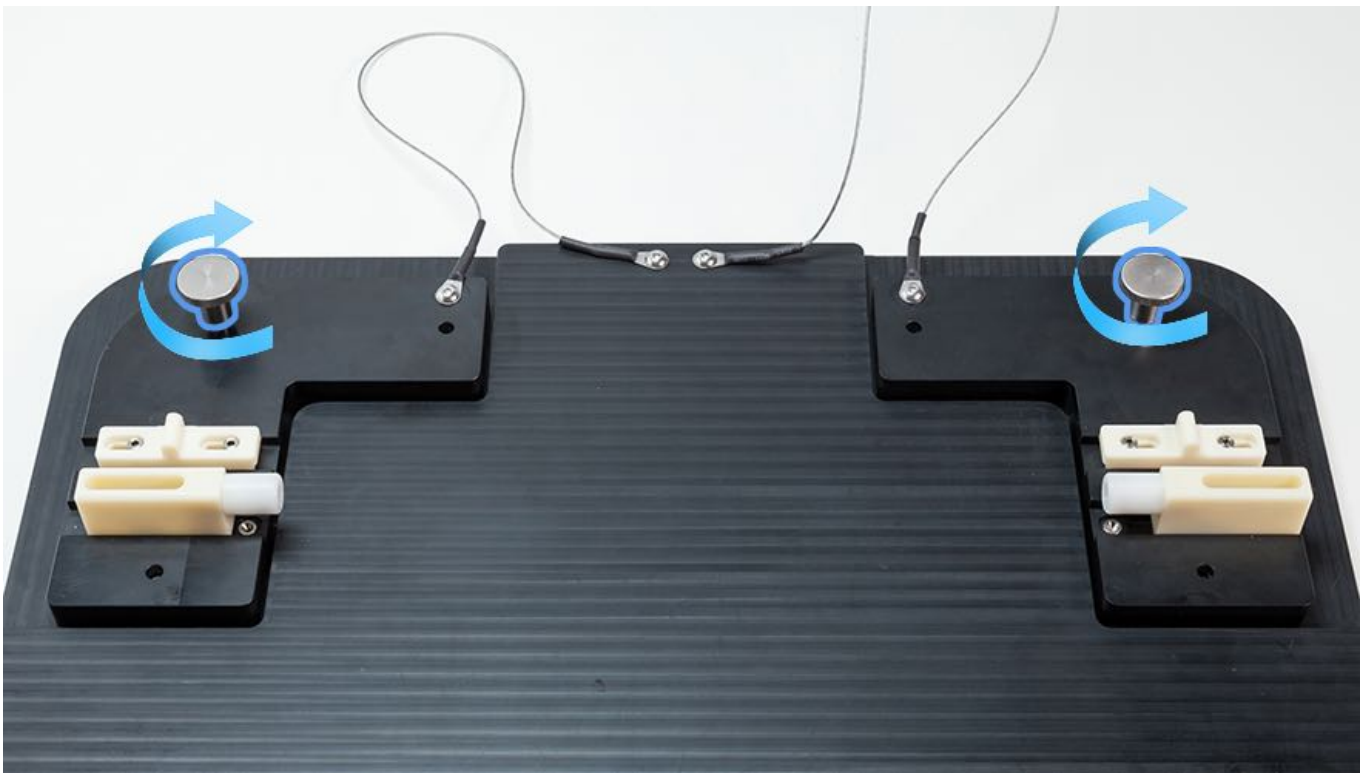
4. Position the corners to accommodate either a 13-inch, 15-inch, or 16-inch computer. Move the braces outward for a 15-inch model as shown, or use the new corners included in the extension kit (076-00459) for a 16-inch model.



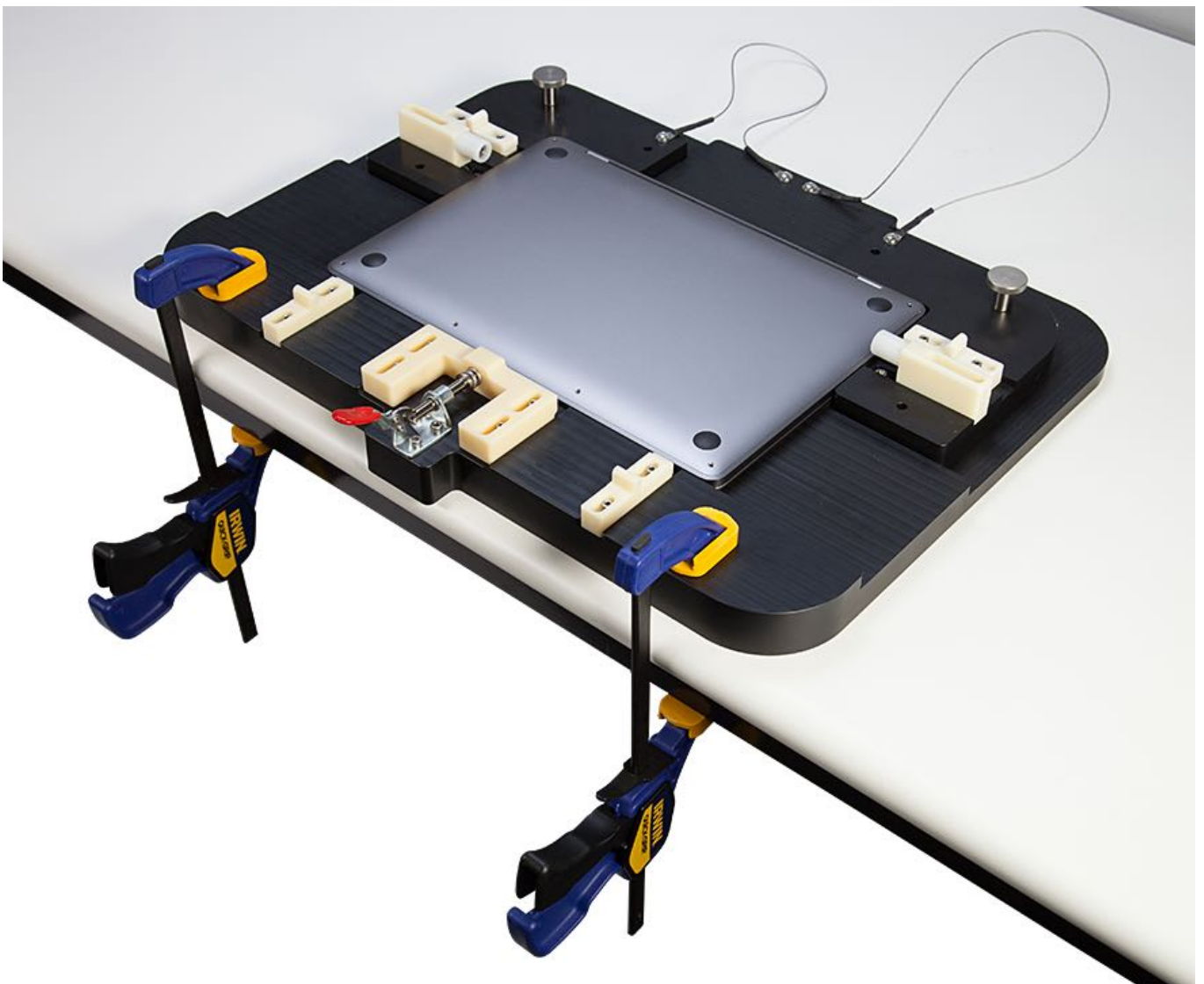
5. Move the braces inward for a 13-inch model, as shown.



6. Once the corners are set, tighten the silver thumbscrews.

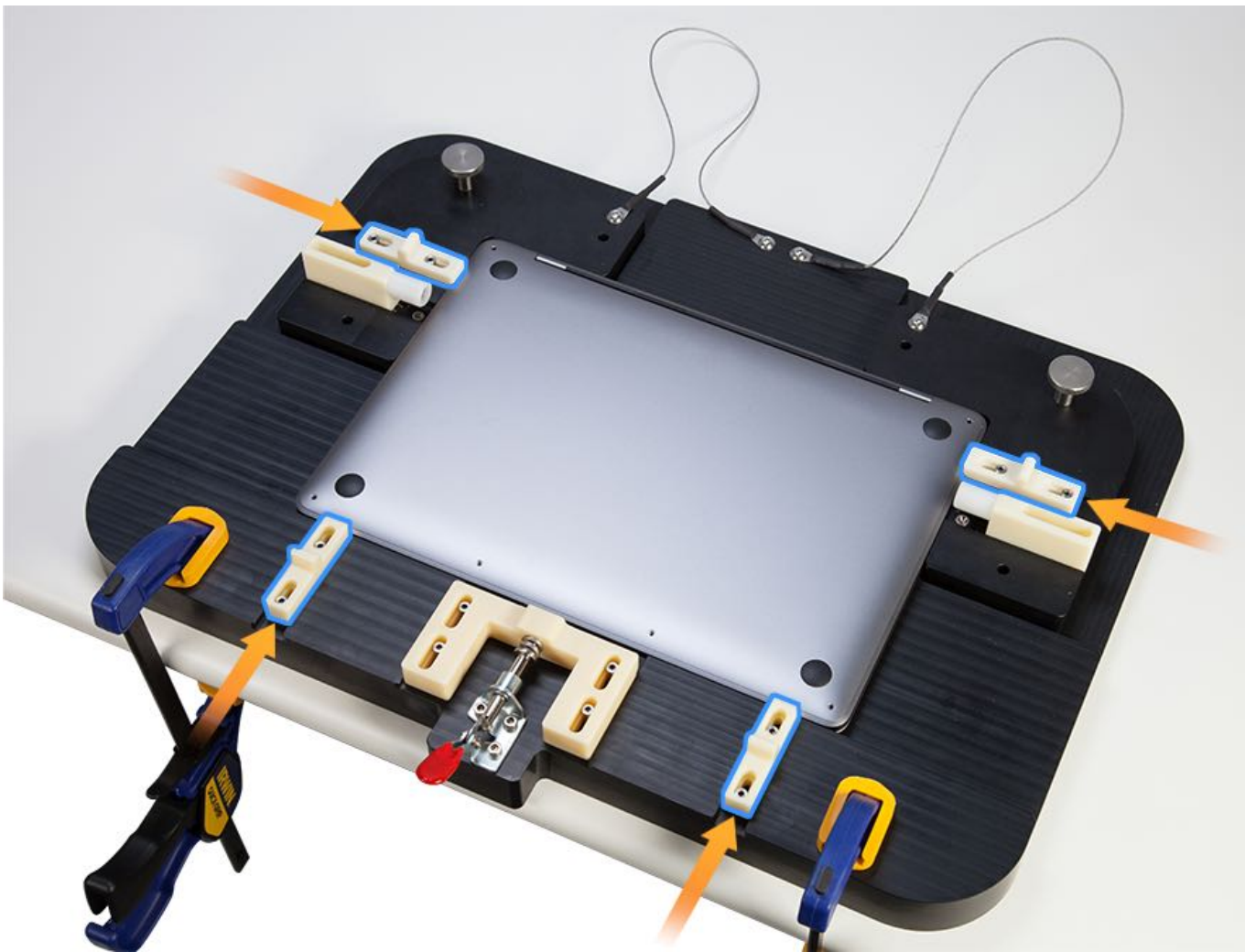


7. Place the computer in the fixture so that the bottom case is faceup and the display hinge is at the top.



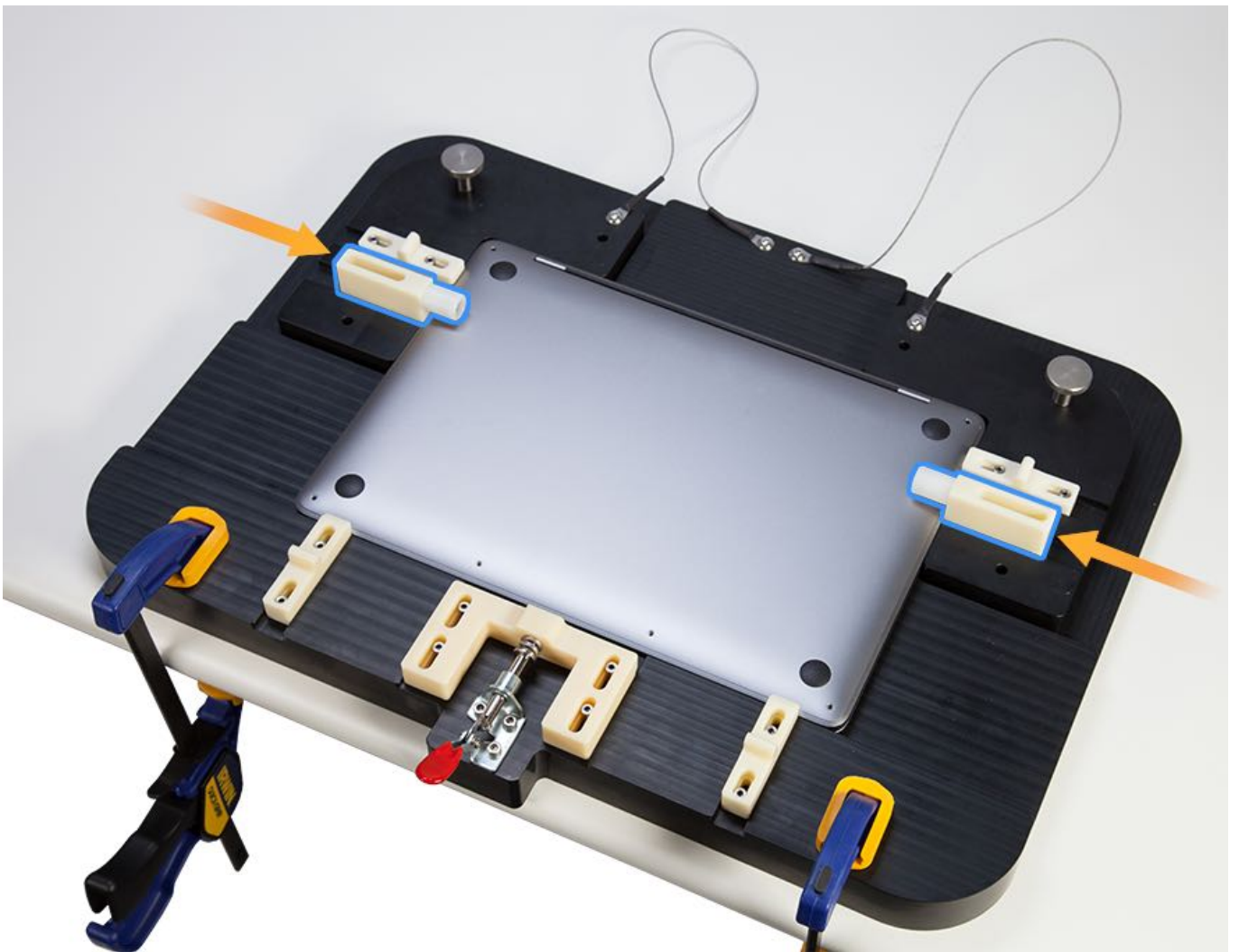
8. Push the four sliding locks inward to hold the computer in place. Ensure the red lever is fully open.



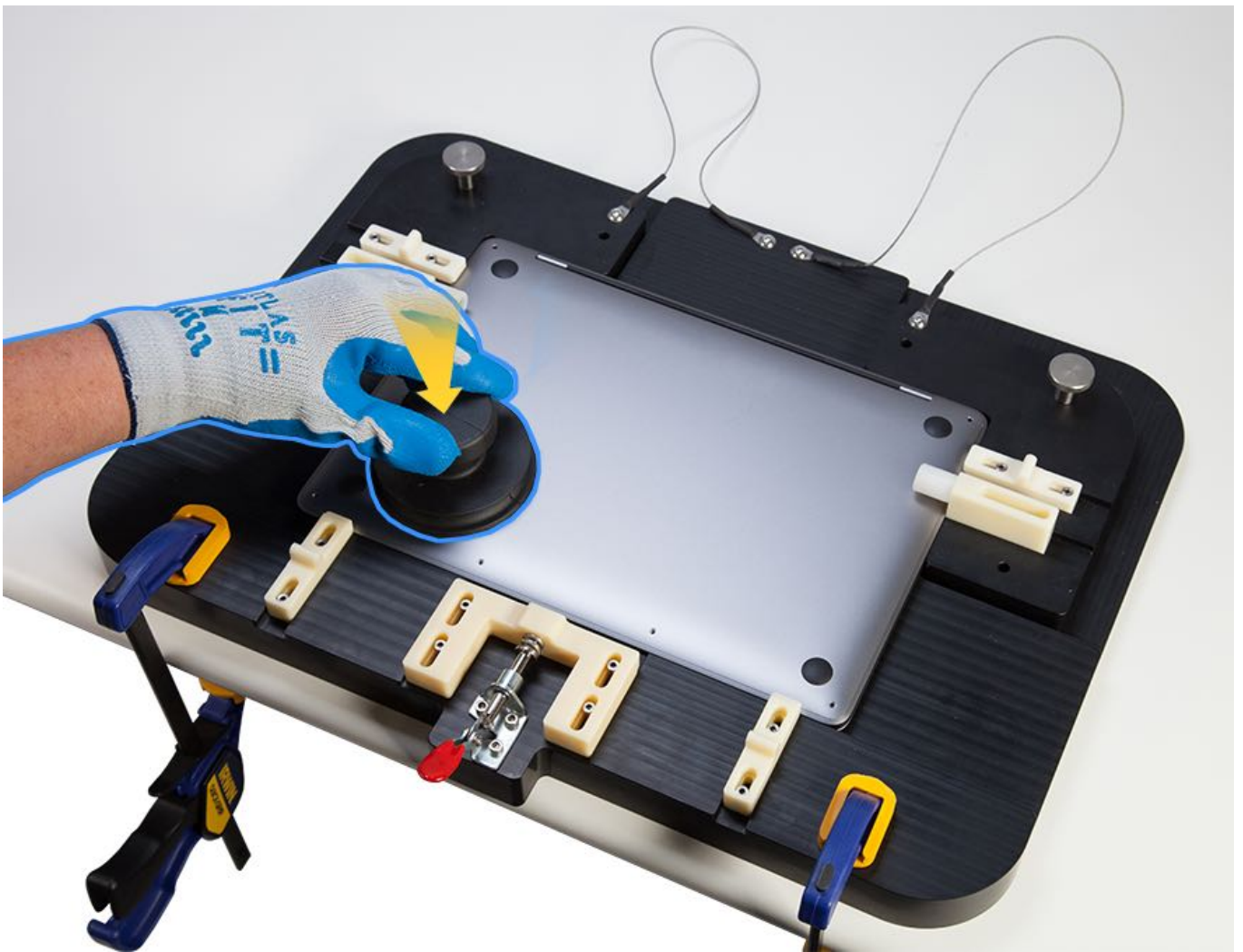


9. Press the two rollers inward. They prevent the bottom case from tilting too far upwards.



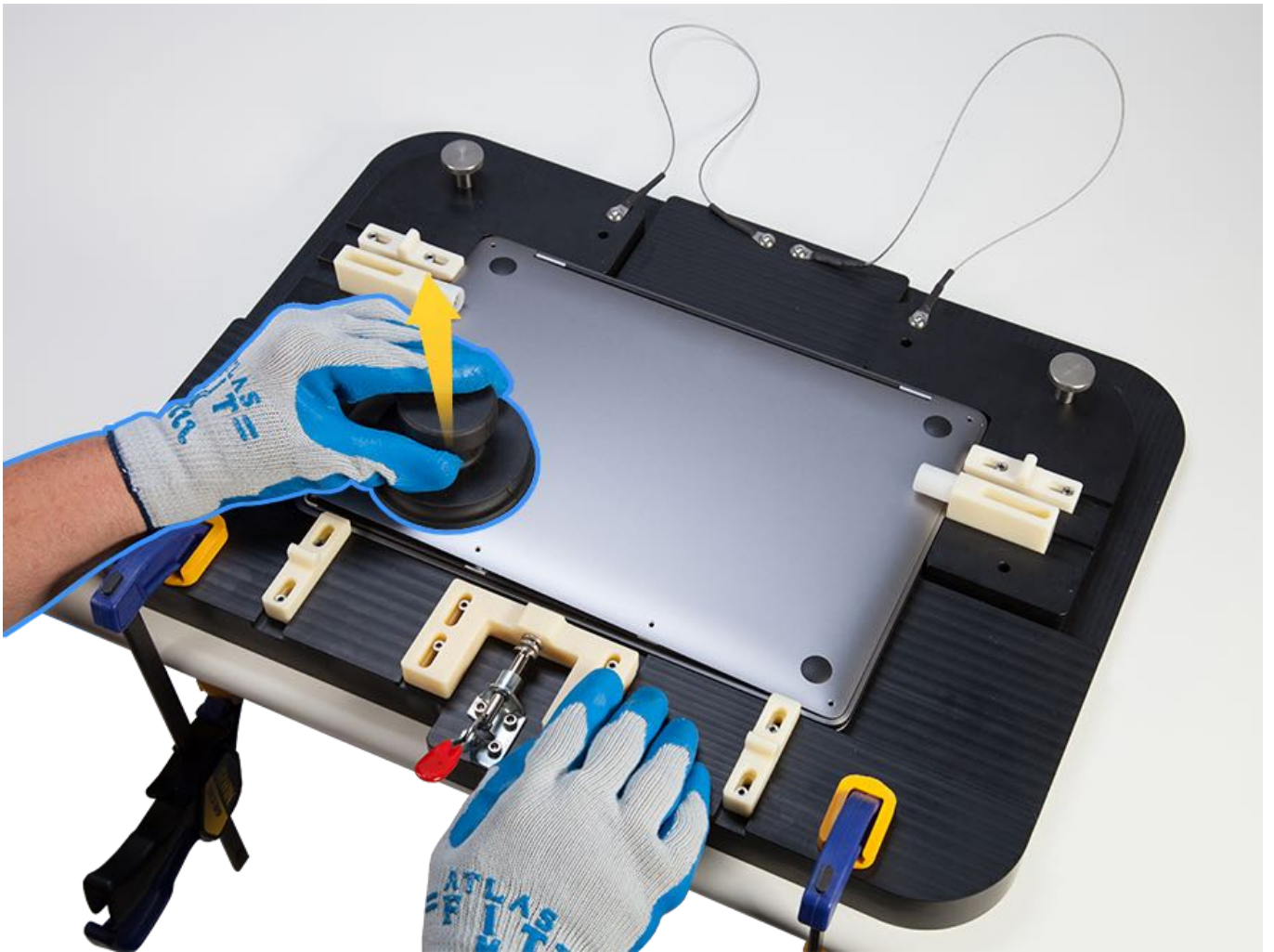


10. Put on the pair of gloves and attach the suction cup at the lower left corner of the bottom case.

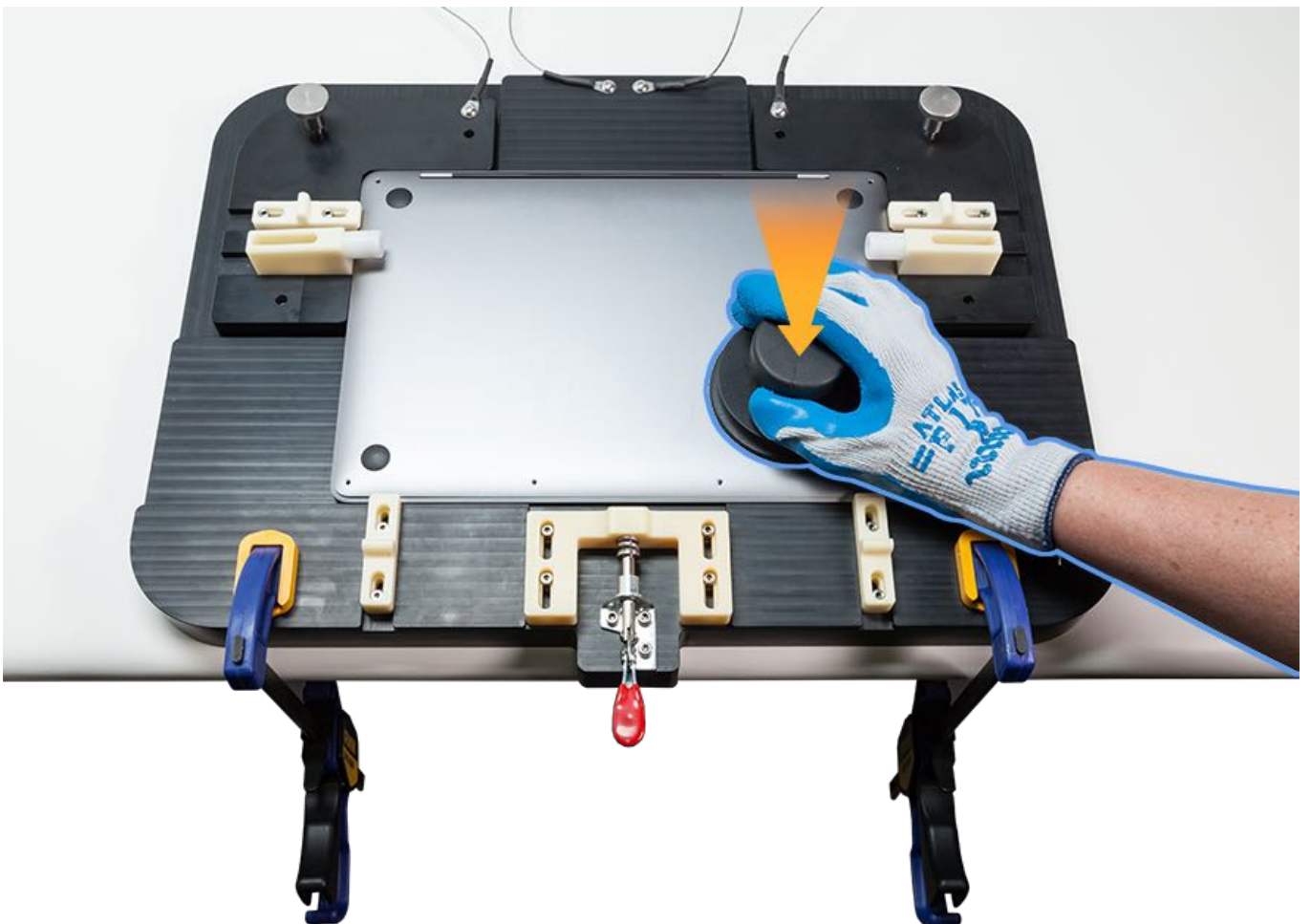


11. Pull up on the suction cup about half a centimeter (0.5 cm), just high enough to lift the bottom case and release two snaps.

**Caution:** Do **not** insert a black stick into the opening. Using a black stick could damage the battery.



12. Move the suction cup to the lower right corner.





13. Pull up the suction cup to release the remaining two snaps.



14. Remove the suction cup. Then insert your index fingers into the narrow opening at the edges closest to you.



15. To protect the computer assembly, keep the opening no more than a finger's width apart.



16. Position both hands so that they are braced in the recessed areas of the fixture. Bracing your hands allows more leverage and protects the internal components when you remove the bottom case.



17. Pull the bottom case toward you.

**Caution:** The spring fingers that secure the bottom case can release suddenly. To prevent the bottom case from sliding over sensitive components, apply gentle and steady pressure to slide the case less than one centimeter.



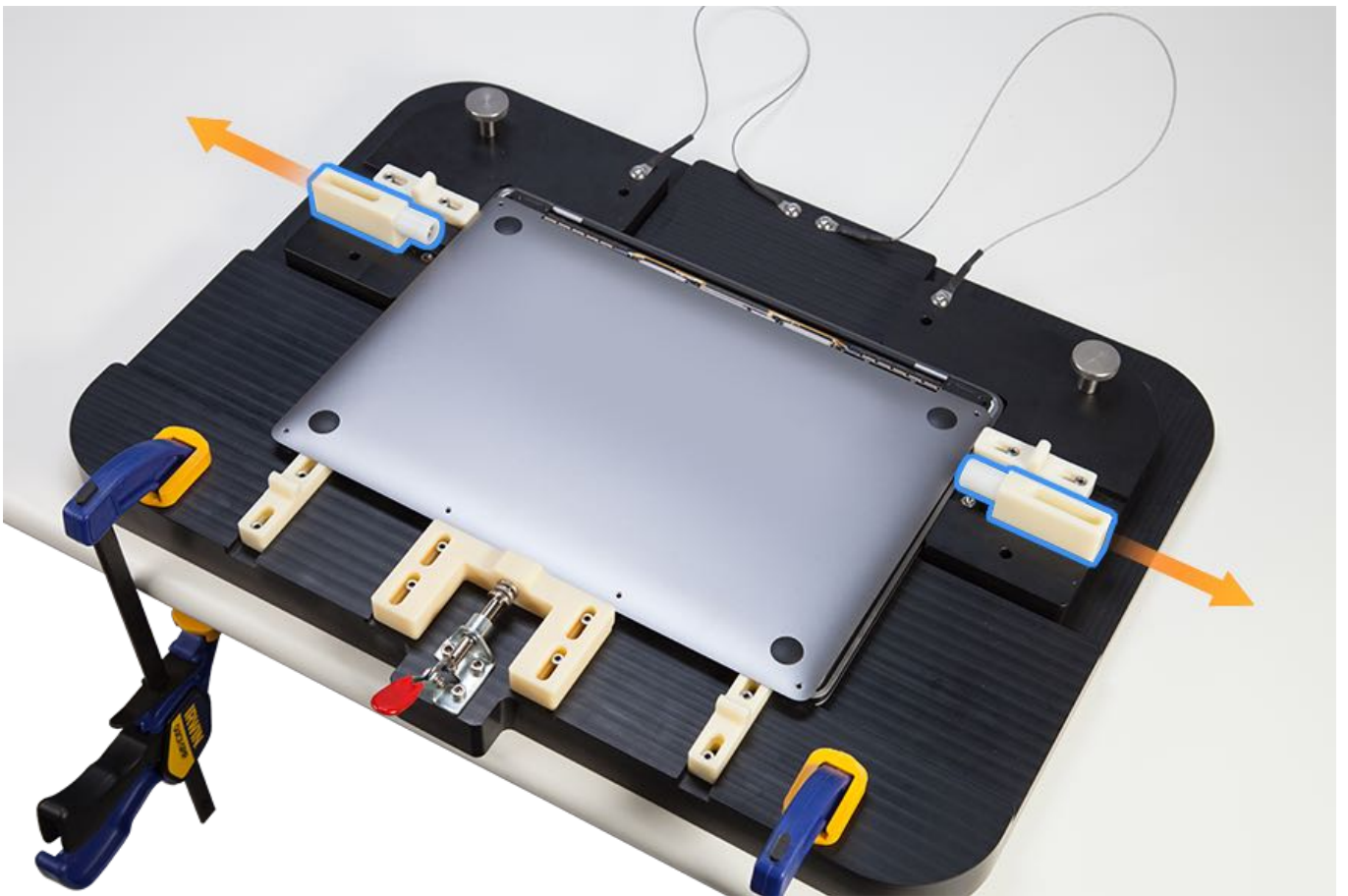


18. Once the spring fingers are disengaged, let the bottom case rest on the computer assembly.

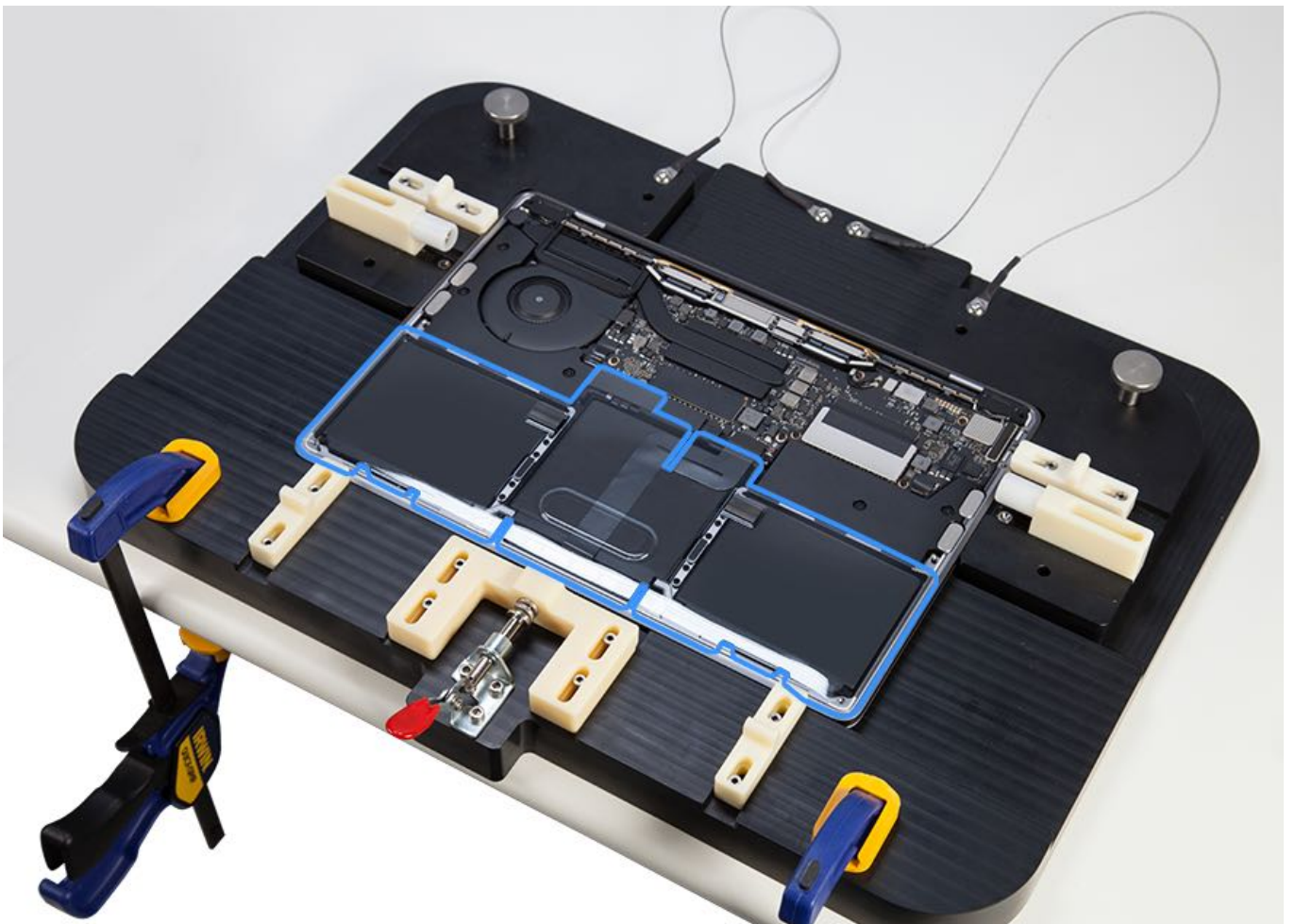


19. Remove the gloves, disengage the two rollers, and remove the bottom case from the fixture.



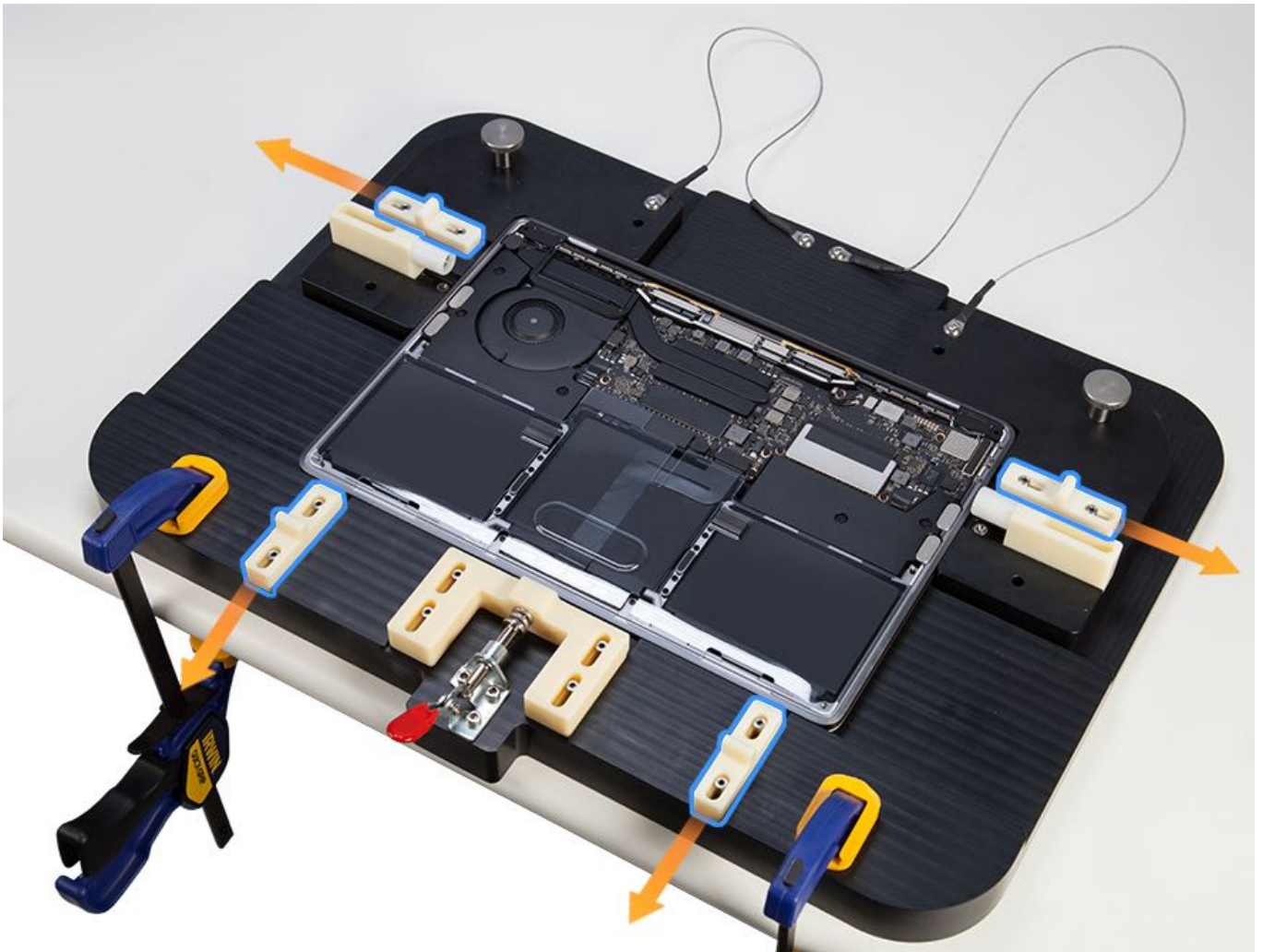


20. Place the protective battery cover on the battery. (The image below shows the 13-inch model.)



21. If you are replacing just the bottom case, go to the reassembly instructions. If you are performing an additional repair on the computer, do not perform that repair while the unit is on the bottom case fixture. Instead, perform the following steps:

- Release the four sliding locks, then lift the computer from the bottom case fixture.
- Transfer the computer to an ESD-safe surface.

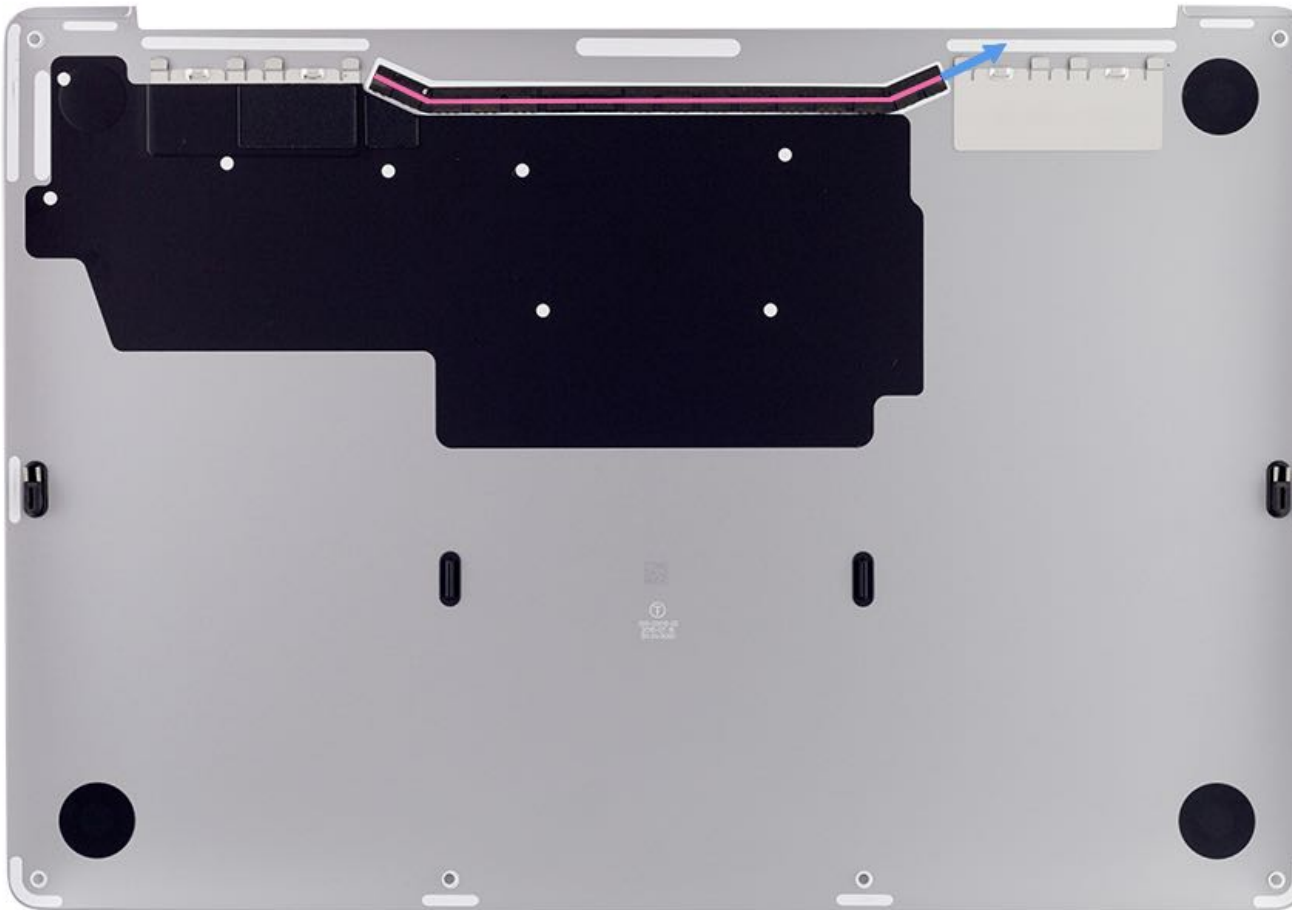


22. Disconnect the battery

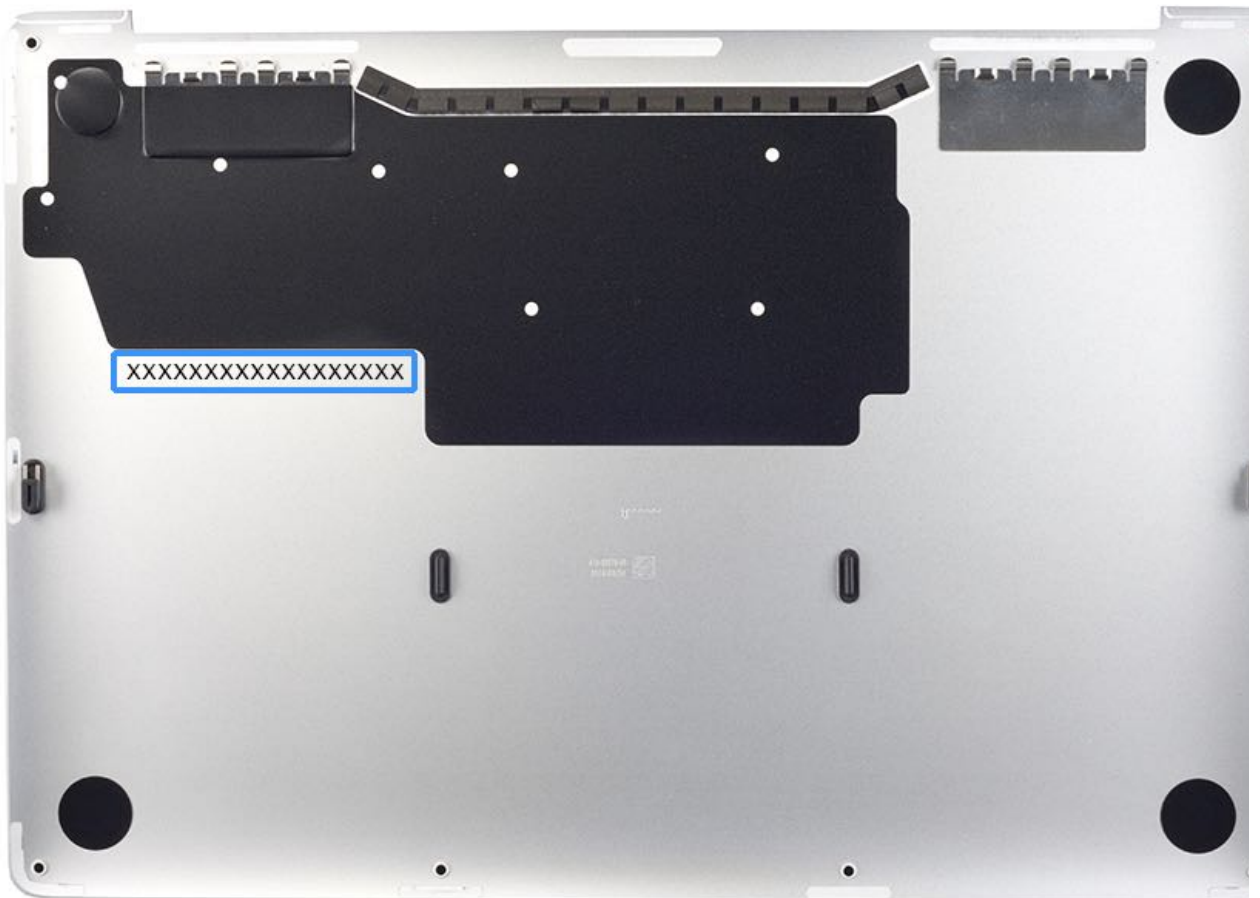
## Steps For Reassembly

1. Before installing a new bottom case, do the following:

- Check the replacement bottom case for a red tube that runs through the air loops. Grasp one end of the red tube and pull it out of the air loop strip. The tube is used only during shipment and should be discarded.



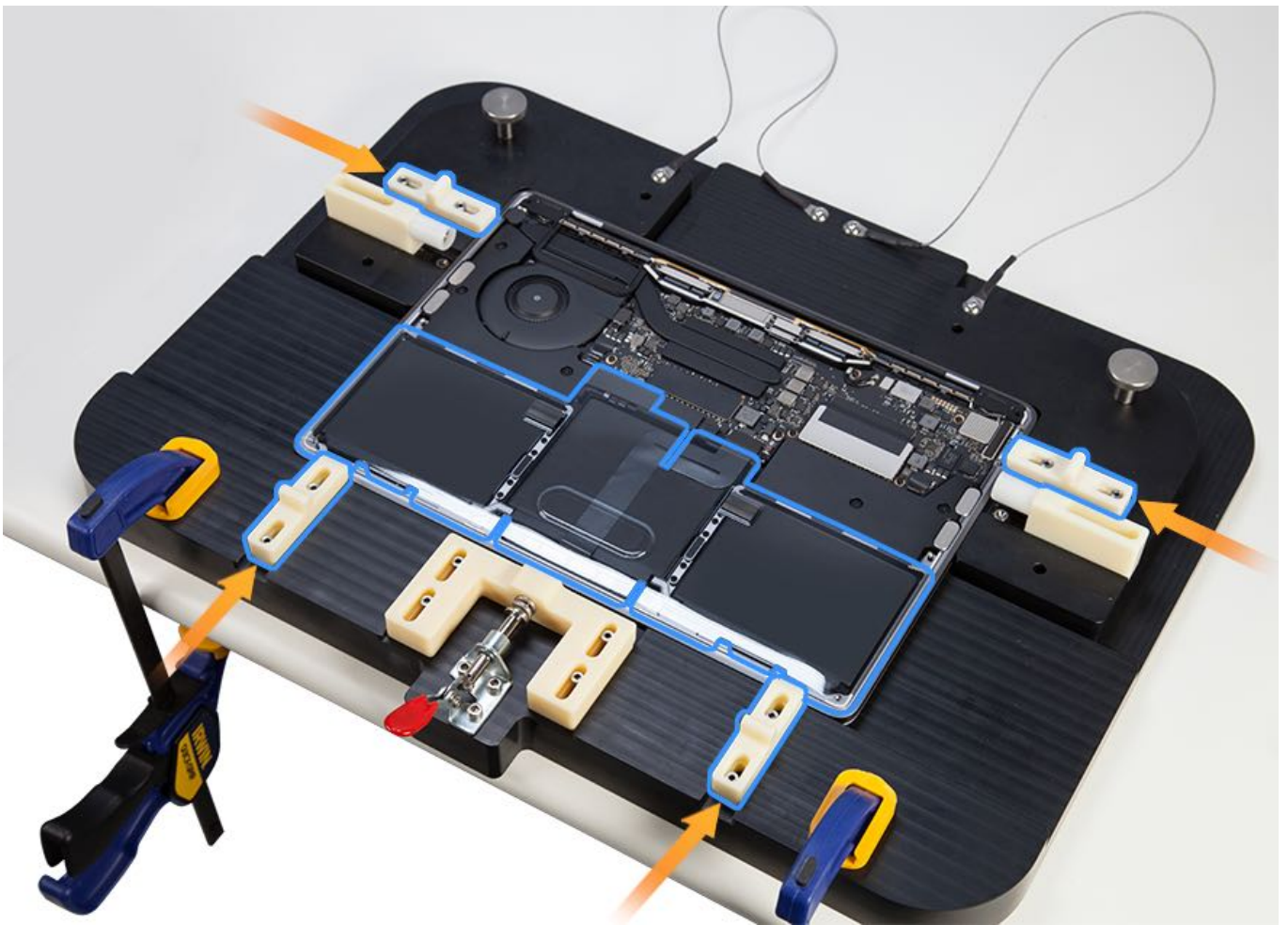
- Retain the original bottom case until the repair is complete. Use a fine-tip permanent marker to write the system serial number on the inside of the replacement bottom case.



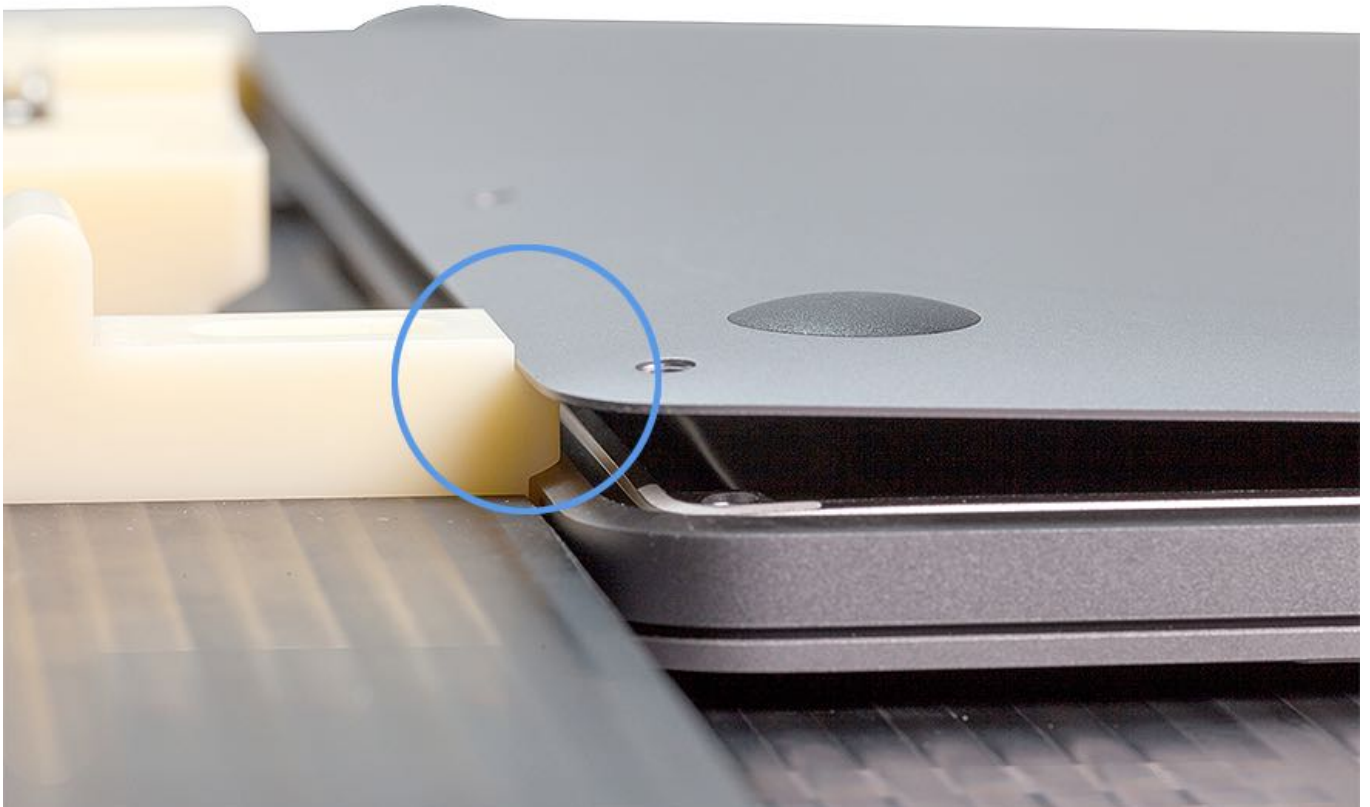




2. Reconnect the battery cable. Then place the computer on the bottom case fixture, making sure the display hinge is away from you.
3. Engage the four sliding locks—**not** the two rollers.
4. Remove the battery cover.



5. Position the bottom case so that its front edge rests on the shelf of the lower two sliding locks.



6. Align the back of the bottom case with the vent/antenna module. The alignment is correct when you can feel that the long edge of the bottom case is flush with the smooth plane of the vent/antenna module.



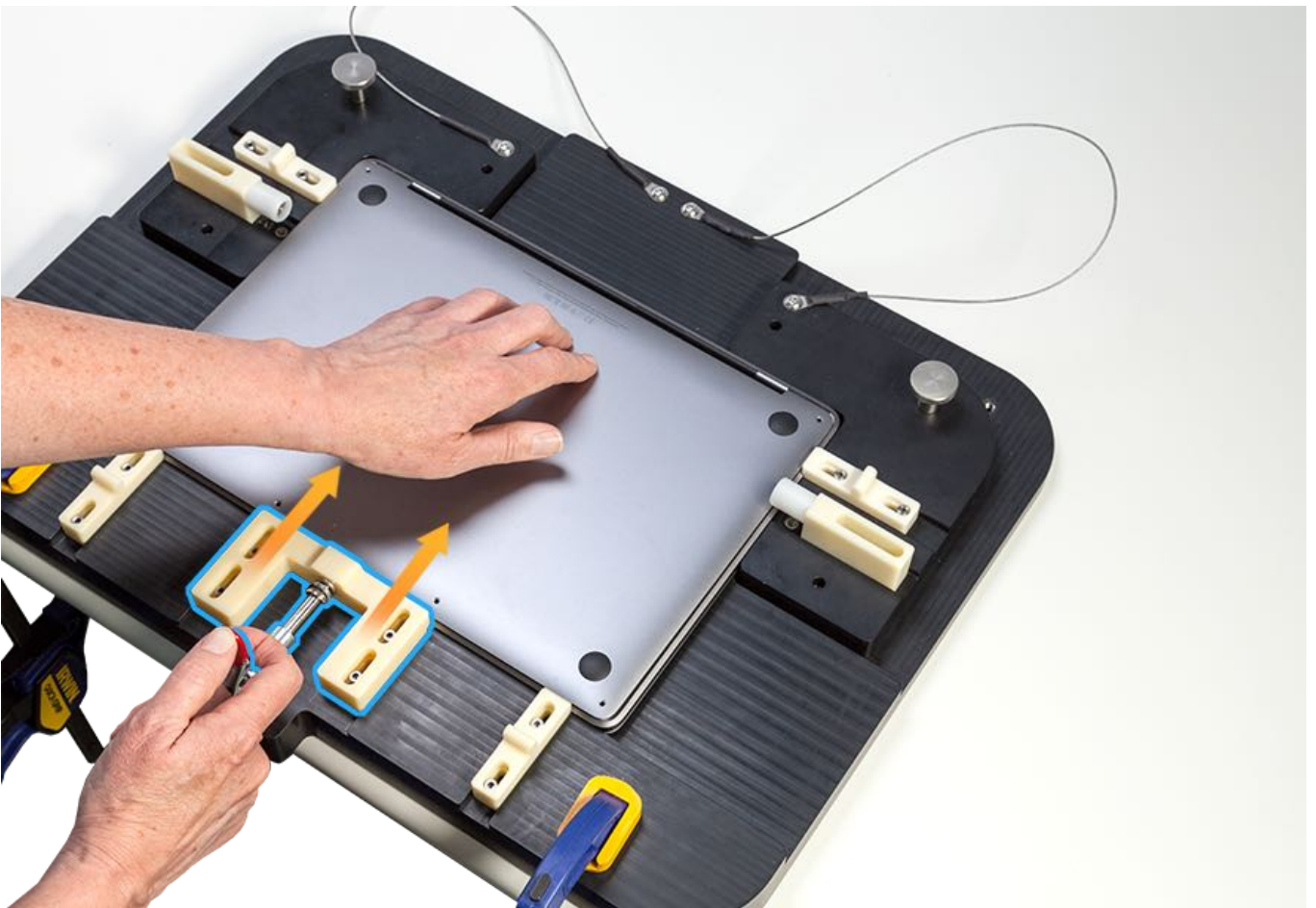
**Important:** When set up correctly, the notches at each rear corner show an equal gap. Likewise, if the bottom case were transparent, the two rows of spring fingers inside the bottom case would start to align with the metal tabs on the vent wall.



7. Hold light pressure near the back center edge of the bottom case while slowly engaging the red lever. Feel the spring fingers engage slightly as you press down on the bottom case.

**Caution:** Pushing the red lever all the way can distort the bottom case and the lever spring.



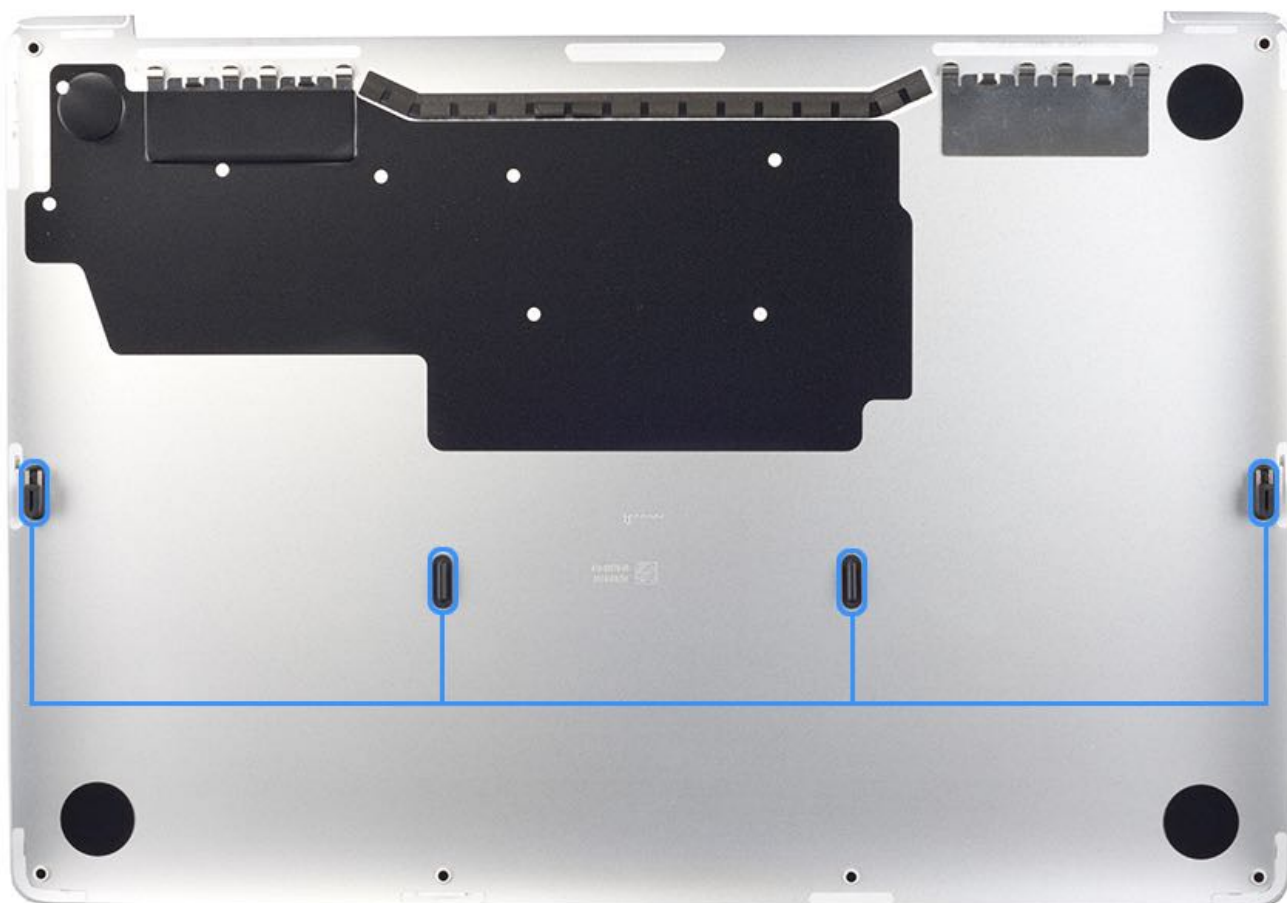
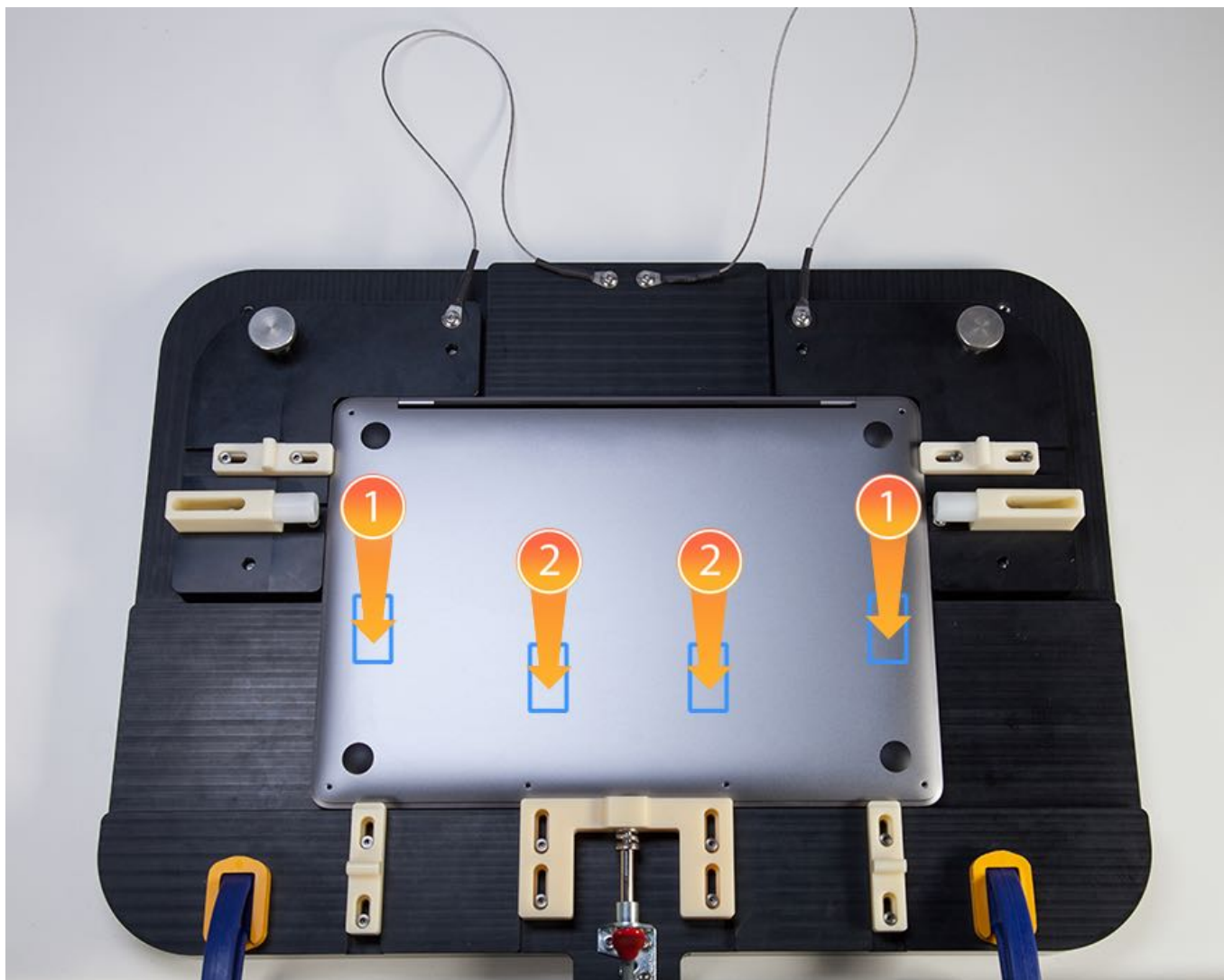


8. As soon as the rear corners of the bottom case meet the top case corners, disengage the lever.

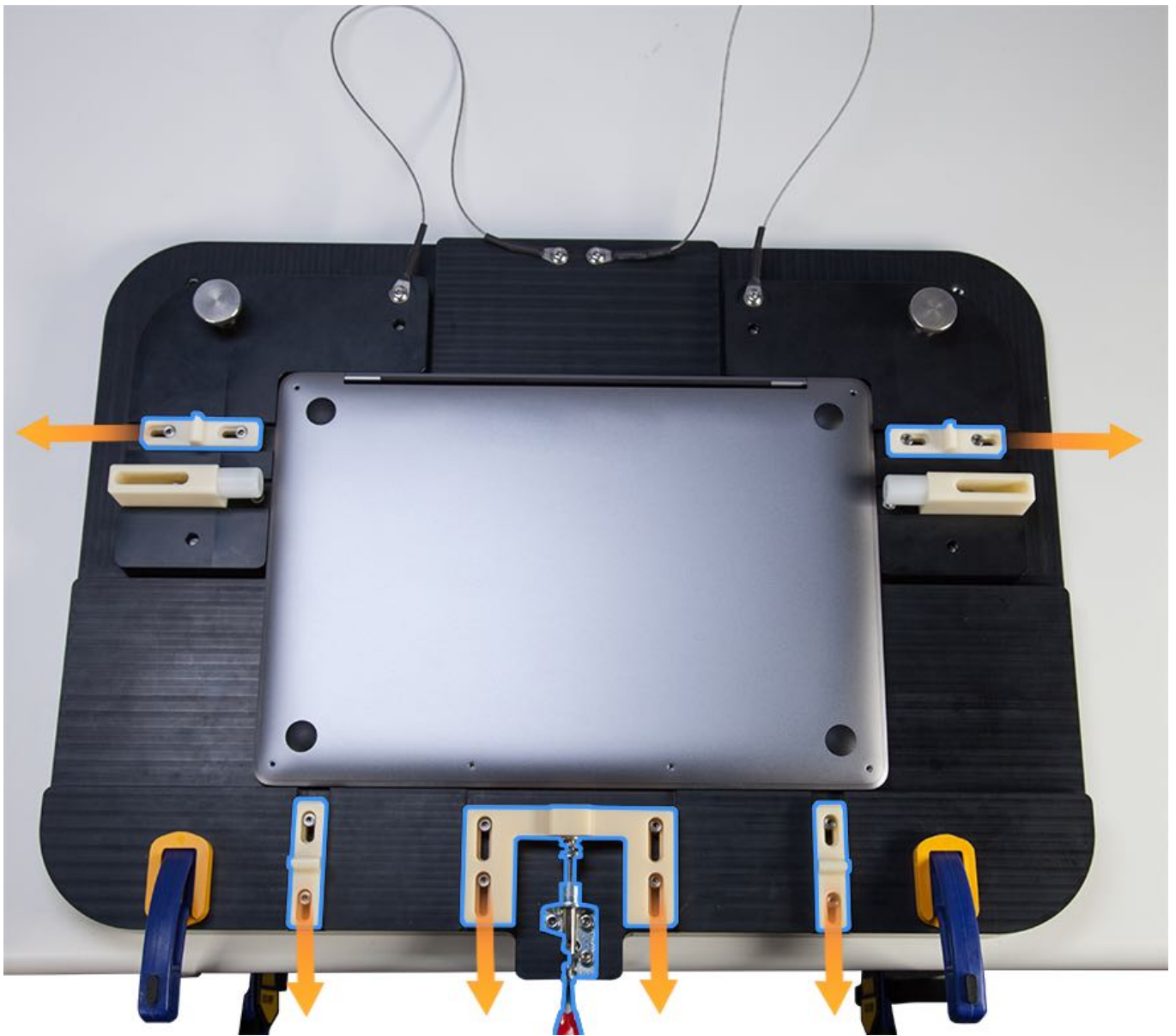
9. If the bottom case is slightly misaligned, use the gripping texture of the gloves to gently apply pressure to adjust the case into alignment. If applying pressure does not realign the bottom case, remove the bottom case and try again.



10. **Important:** First press the sides (1) of the bottom case to snap the two clips in the top case. Then press the middle (2) of the bottom case for the two remaining clips.



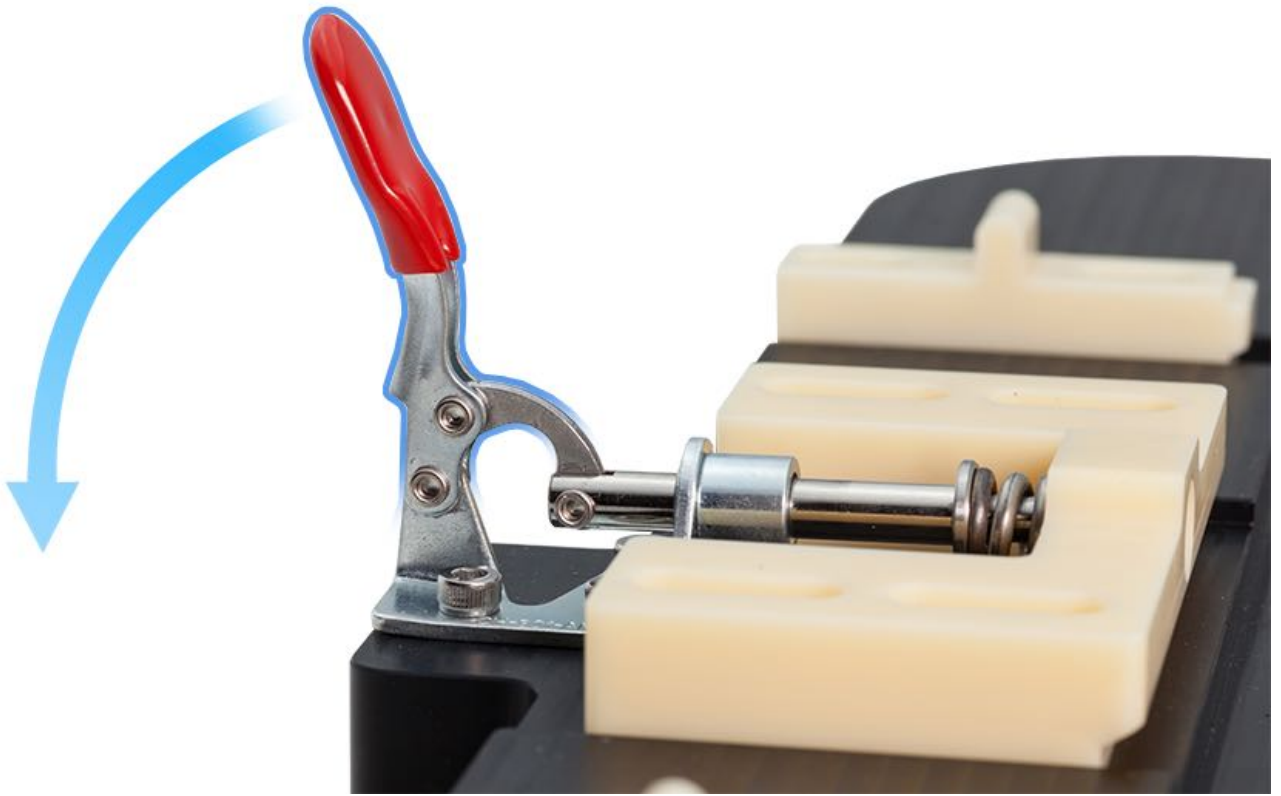
11. Fully disengage the four sliding locks.



12. Remove the computer from the bottom case fixture.

**Note:** When storing the bottom case fixture, make sure that the red lever is not engaged. Keeping the red lever vertical or fully open protects its inner spring.





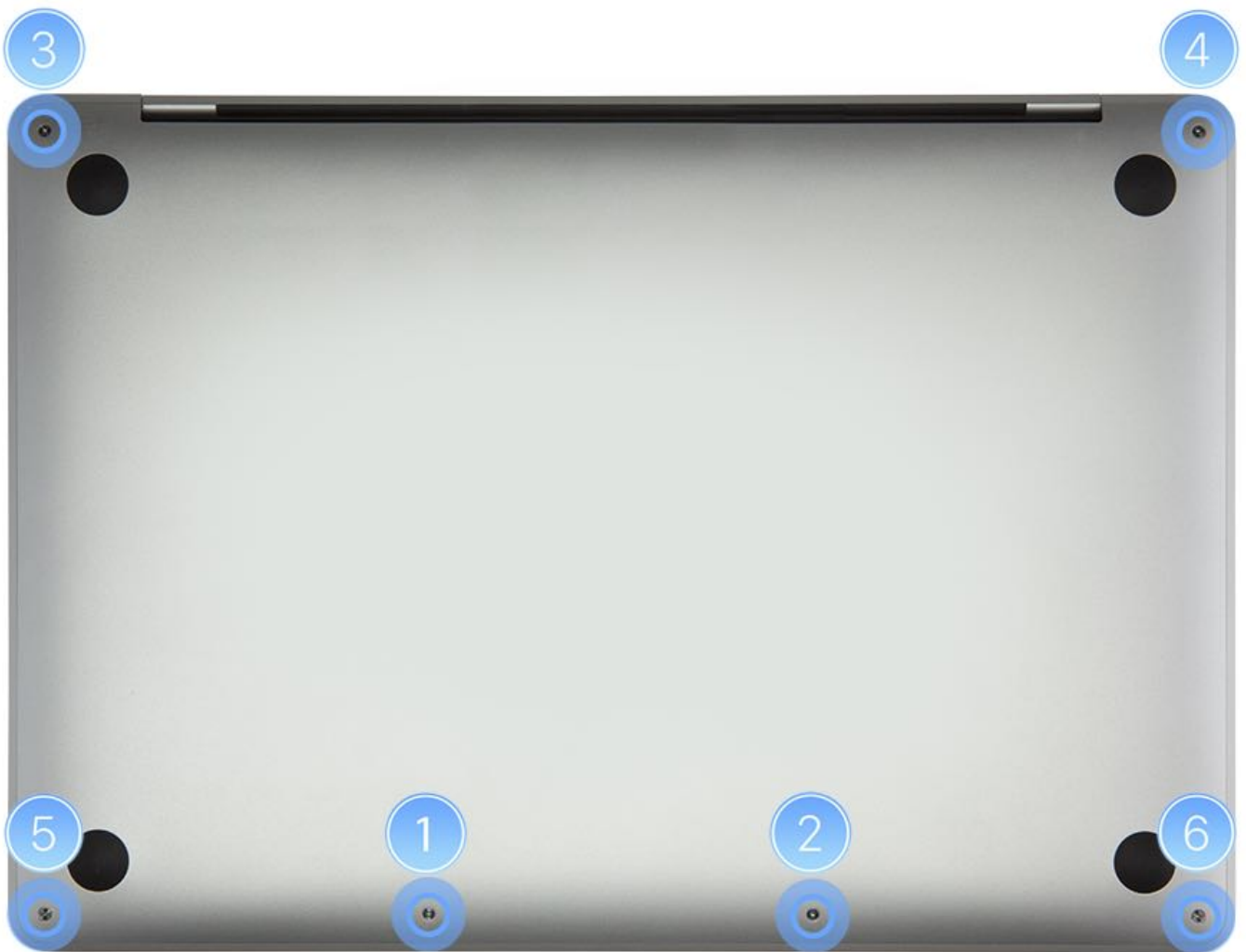
13. Check all sides of the bottom case for proper alignment with the top case.



14. Install the six bottom case screws in the following order and see image below:

- Install the short screws at the middle front (1 and 2).
- Install the longest screws at the rear corners (3 and 4).
- Install the medium-length screws at the front corners (5 and 6).

**Note:** MacBook Pro (13-inch, 2016, 2017, 2018, 2019, Four Thunderbolt 3 Ports), MacBook Pro (15-inch, 2016, 2017, 2018, 2019), and MacBook Pro (16-inch, 2019) only have two sizes of screws but the reinstallation order is the same as above.



15. Follow the instructions in [Trackpad Calibration Check](#) to verify the trackpad performance after every repair.

# Battery Cover and Disconnecting the Battery

## First Steps



### Warning:

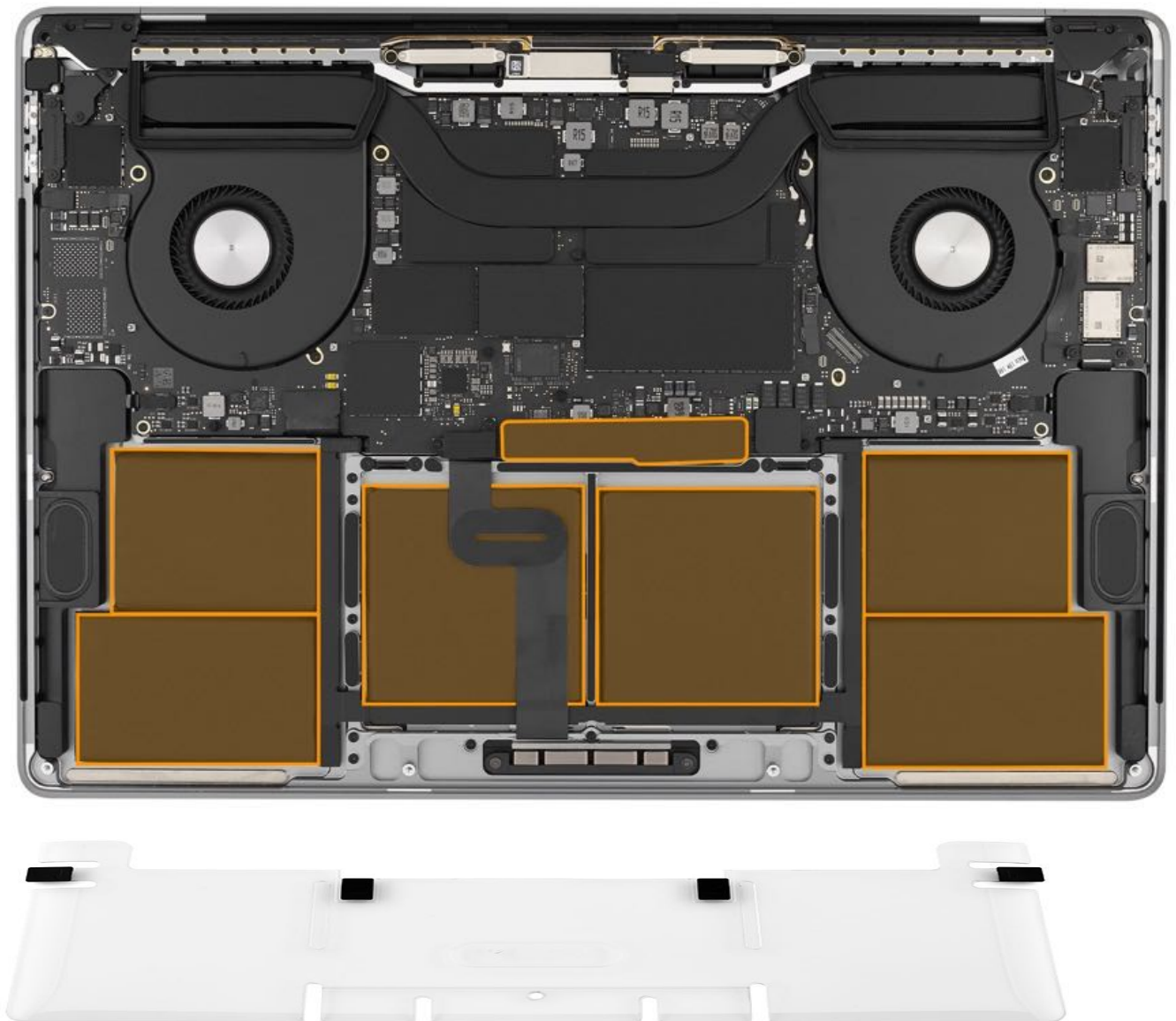
- To avoid damaging parts, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw before you begin a repair.
- Do not apply external power while the computer is under repair.

### Important:

- Only [Apple-certified technicians](#) (OP1859) should perform this procedure.
- Wear an ESD wrist strap and take precautions to avoid ESD.

### Remove:

- [Bottom case](#)



## Tools

- ESD-safe tweezers
- Black stick



- Torx T5 screwdriver
- ESD wrist strap
- Battery cover, 923-03891



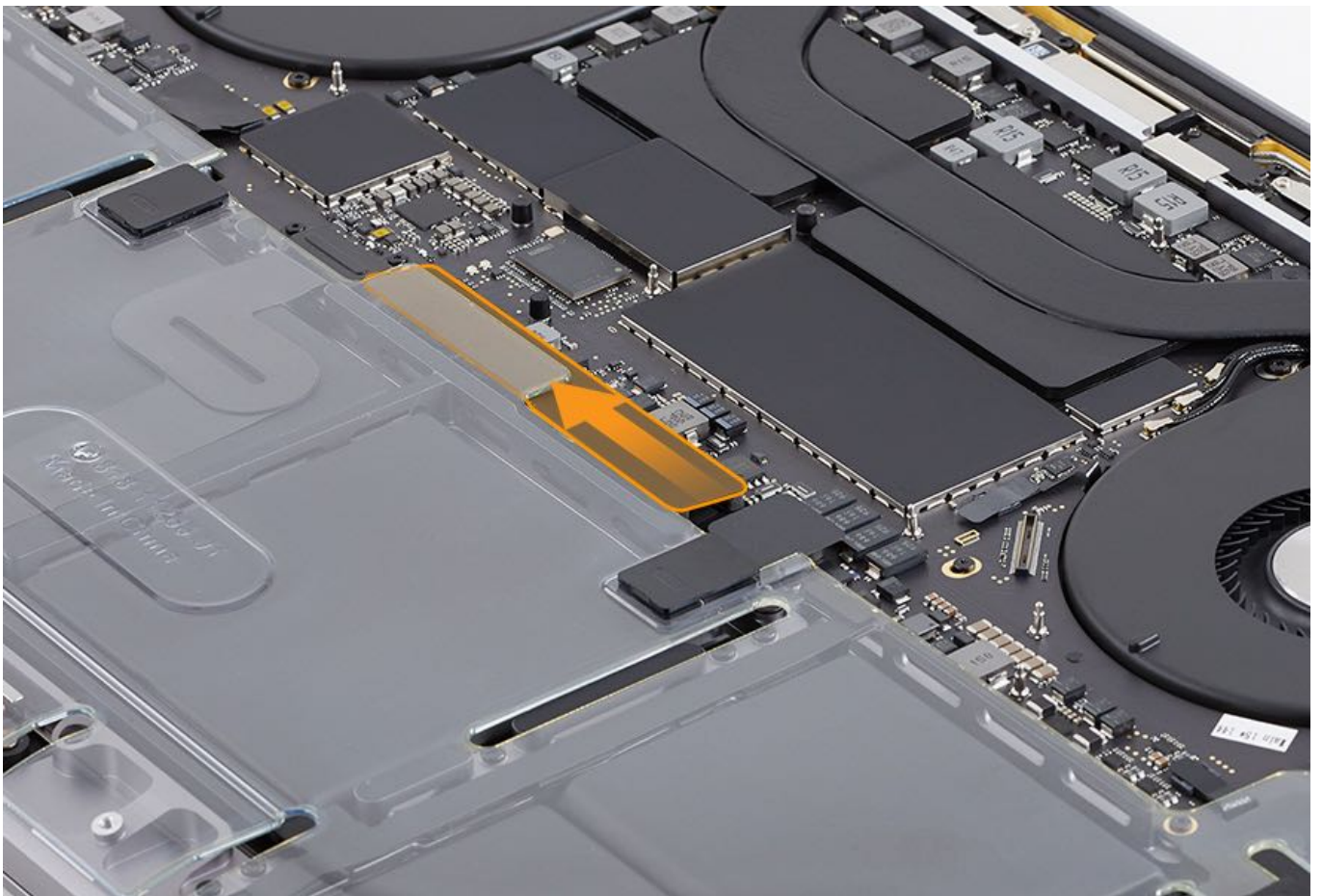
## Steps For Removal

**Note:** Most images were taken with a pre-production battery cover, your battery cover may look different.

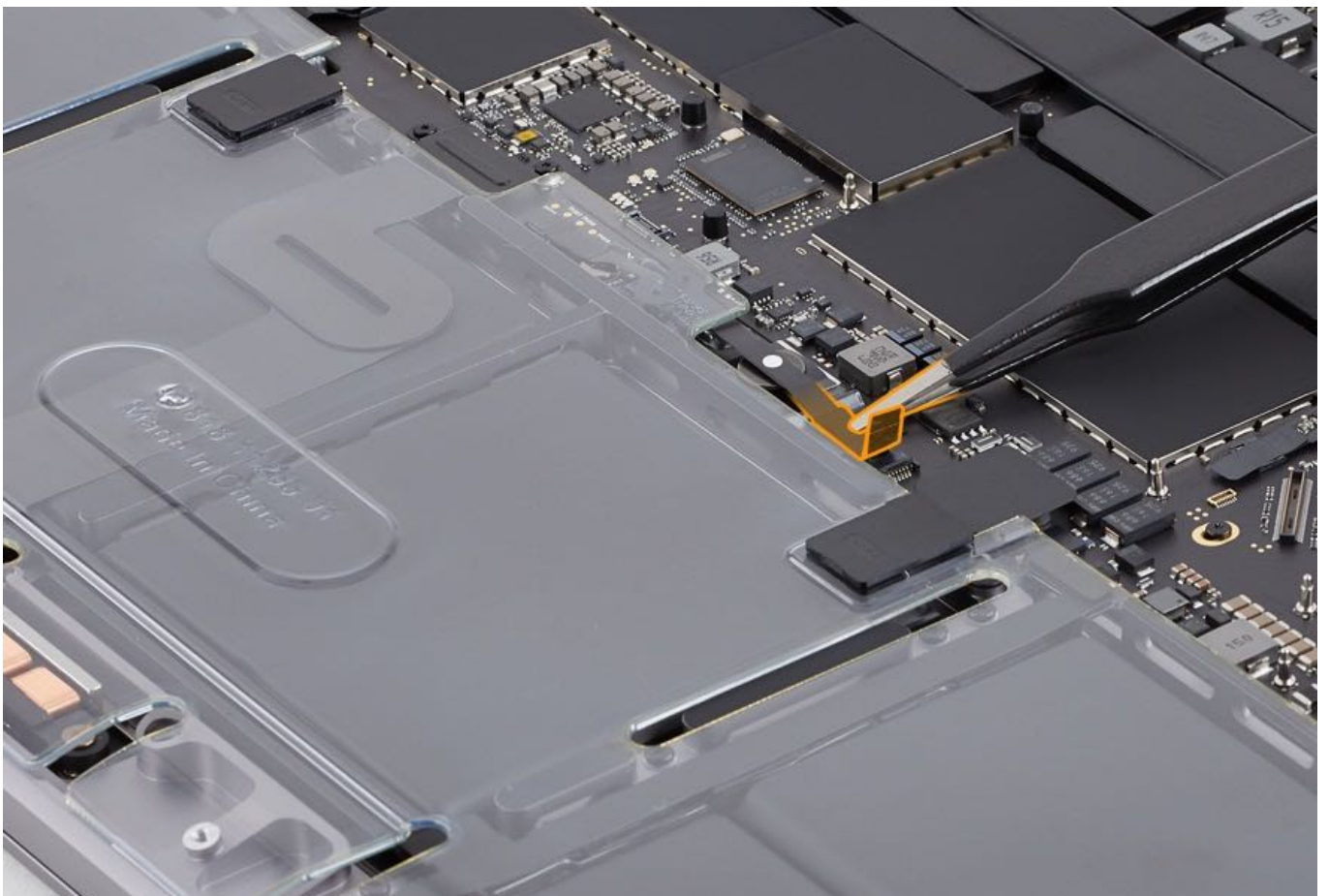
1. Tilt the bottom tabs of the battery cover into the slots at the bottom edge of the top case.
2. Carefully lower the cover onto the battery cells, making sure the tabs on the sides of the cover fit into the notches on the edges of the top case.
3. Securely attach the battery cover with two clips that snap onto the midwall of the top case.



4. Remove the Mylar BMU cover and set it aside to be reinstalled.



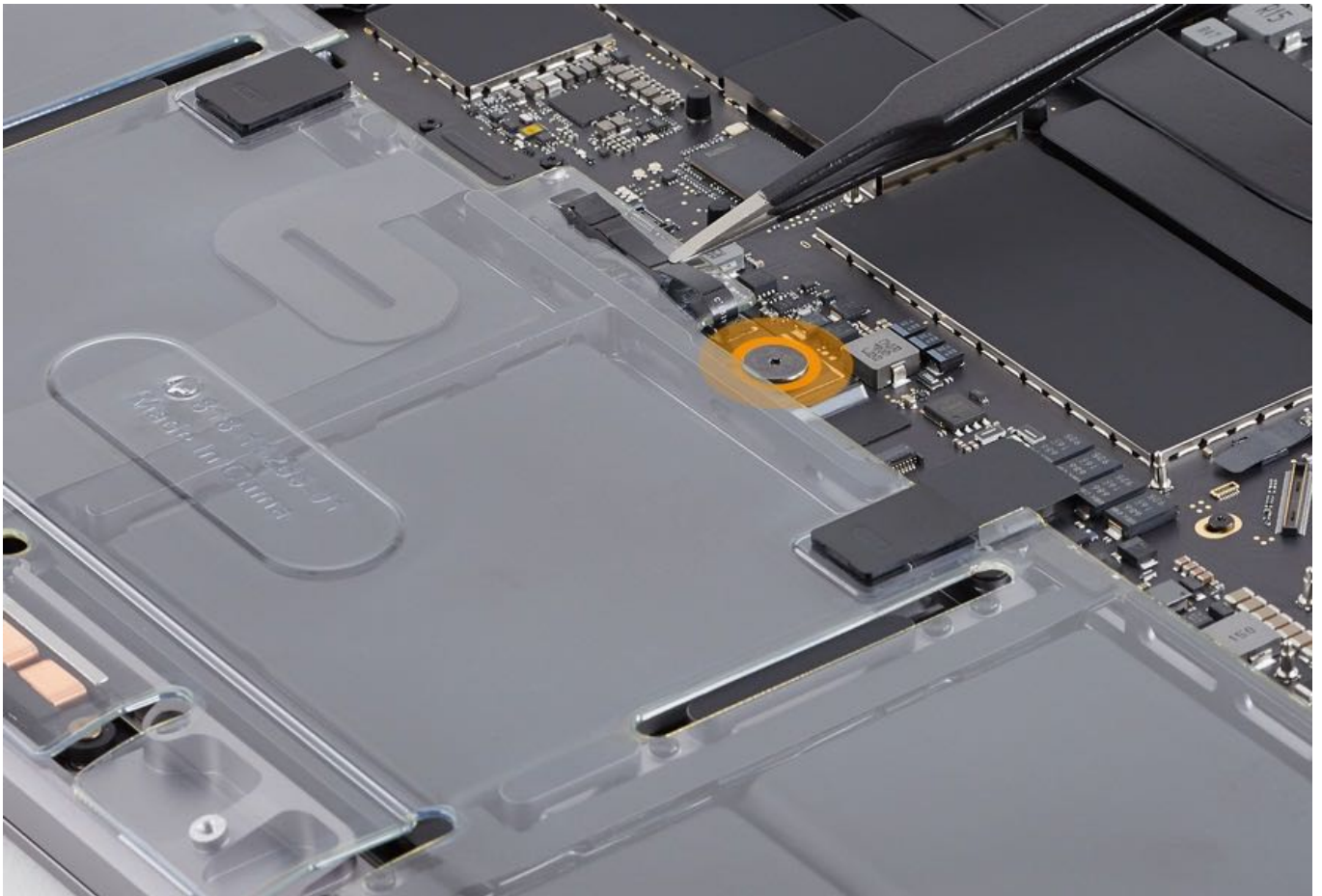
5. Use tweezers to lightly grasp the Mylar tab covering the battery flex cable connector and gently peel back the tab to expose the locking lever. Then lift the locking lever and carefully remove the flex cable from the connector.



8. Remove the Torx T5 BMU screw.

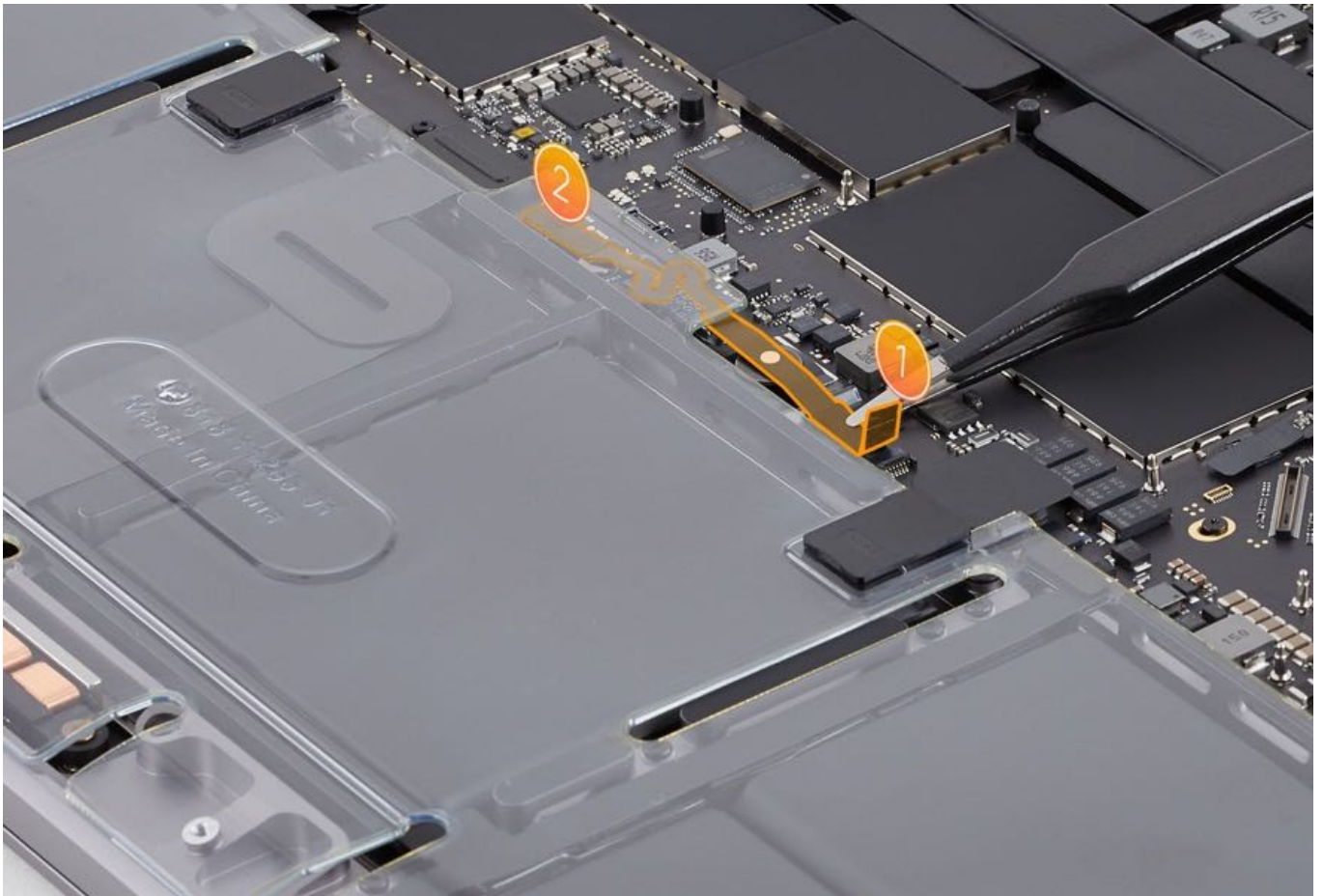


- T5: 923-03912



**Note:** If replacing the BMU flex cable, lift the locking lever from the connectors on each end of the flex cable and disconnect the flex cable from the right and from the left.





**Warning:** Allow the battery to discharge for one minute before proceeding with any repairs involving the logic board.

## Steps For Reassembly

Reassemble in reverse order of removal steps.

Notes for reassembly:

- Reinstall the BMU screw, reconnect the battery flex cable, and remove the battery cover.
- Be sure to reinstall the BMU cover.
- Follow the instructions in [Trackpad Calibration Check](#) to verify the trackpad performance after every repair.

# Clutch Covers

## First Steps



### Warning:

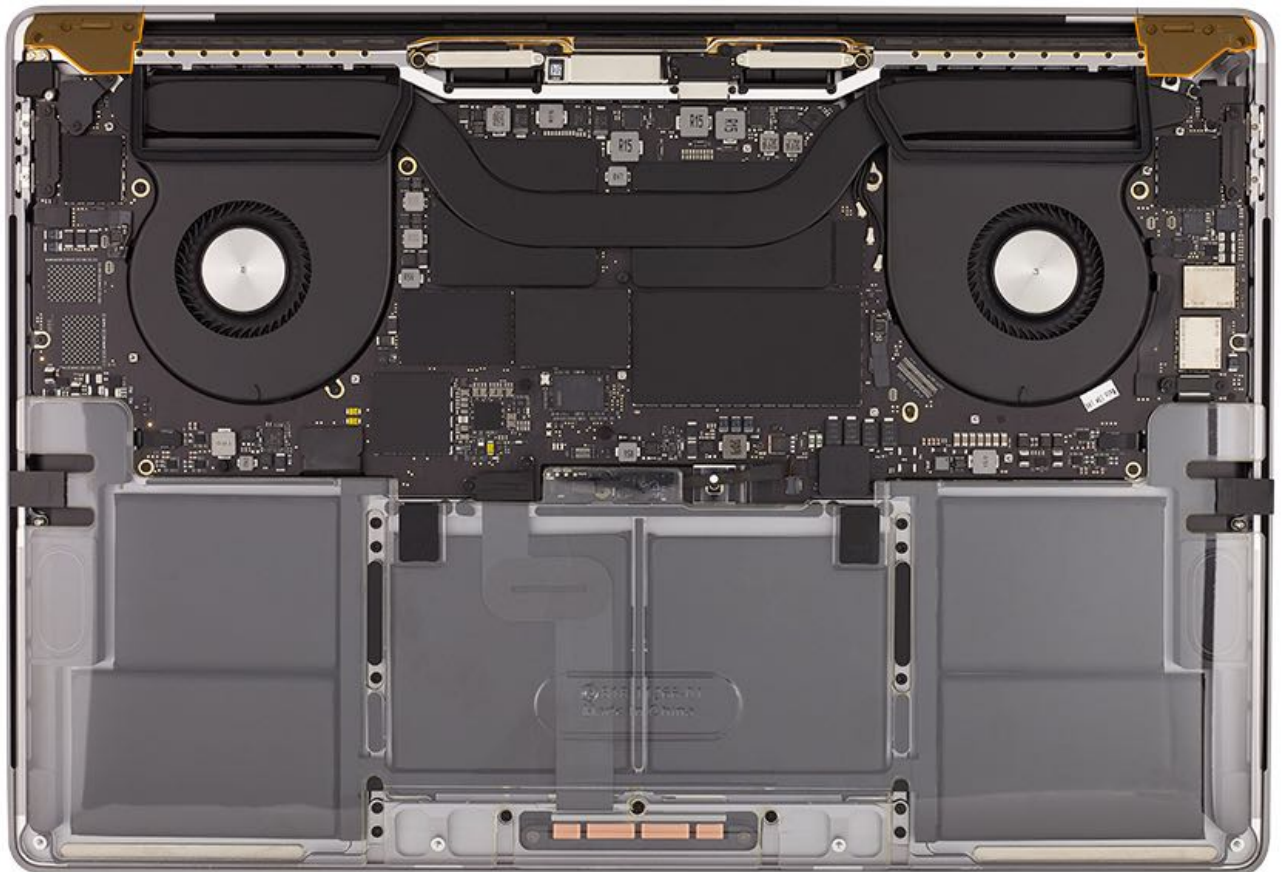
- To avoid damaging parts, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw before you begin a repair.
- Do not apply external power while the computer is under repair.

### Important:

- Only Apple-certified technicians should perform this procedure. Wear an ESD wrist strap and take precautions to avoid ESD.
- 

### Remove:

- [Bottom case](#)
- [Attach battery cover and disconnect battery](#)



## Tools

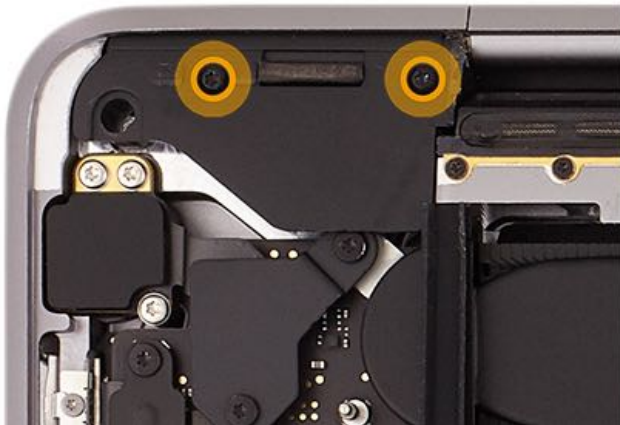
- Torx T3 screwdriver
- Black stick



## Steps For Removal

1. Remove two T3 screws from both the left and the right clutch covers.

- T3: 923-01286



2. Use a black stick or your fingers to lift up each clutch cover and remove it from the top case.





## Steps For Reassembly

1. Reassemble in reverse order of removal steps.

**Note:** Reinstall each clutch cover so the top edge of the clutch cover seats under the top edge of the top case.



2. Reinstall the [BMU screw](#), [reconnect the battery](#), and [remove the battery cover](#).

3. Reinstall the [bottom case](#).
4. Follow the instructions in [Trackpad Calibration Check](#) to verify the trackpad performance after every repair.

# Audio Board

## First Steps



### Warning:

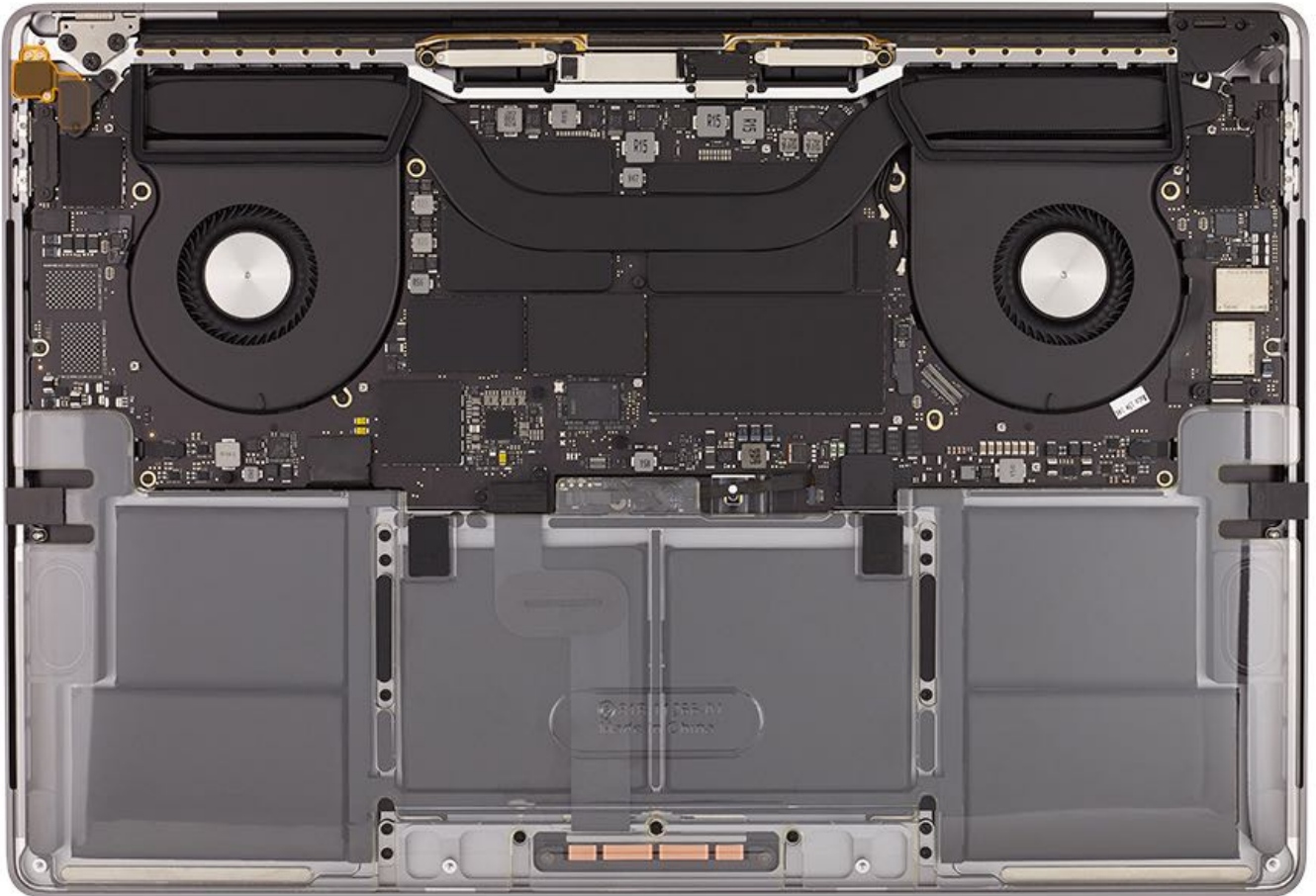
- To avoid damaging parts, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw before you begin a repair.
- Do not apply external power while the computer is under repair.

### Important:

- Only Apple-certified technicians should perform this procedure. Wear an ESD wrist strap and take precautions to avoid ESD.
- 

### Remove:

- [Bottom case](#)
- [Attach battery cover and disconnect battery](#)
- [Clutch cover](#) (right only)



## Tools

- Torx T3 screwdriver (magnetized)
- Black stick



## Steps For Removal

1. Remove the two T3 screws from the Touch ID board cowling. Remove the cowling.

- T3: 923-01506



2. Remove the three T3 screws from the audio board.

- T3: 923-02530 (washer included)







3. Disconnect the audio board flex cable from the logic board.



4. Gently grasp the edges of the audio board flex cable and remove the board from the top case.  
**Note:** Do not pinch or put pressure on the flex cable.





## Steps For Reassembly

**Note:** Be sure to order the correct part when replacing the audio board.

- Space Gray: 923-03902
- Silver: 923-03903

1. Reinstall the audio board.



2. Partially reinstall the three T3 screws to keep the audio board in place.

- T3: 923-02530 (washer included)



3. Plug in earphones with a 3.5 mm jack to check alignment. Once the audio board is properly aligned, fully tighten the audio board screws.



4. Reconnect the audio board flex cable.
5. Reinstall the Touch ID board cowling and the two T3 screws.
  - T3: 923-01506



6. Reinstall the right [clutch cover](#).
7. Reinstall the [BMU screw](#), [reconnect the battery](#), and [remove the battery cover](#).
8. Reinstall the [bottom case](#).
9. Follow the instructions in [Calibration Check](#) to verify the trackpad performance after every repair.

# Logic Board

## First Steps



### Warning:

- To avoid damaging parts, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw before you begin a repair.
- After disconnecting the battery, allow it to discharge for one minute before proceeding with this repair.
- Do not apply external power while the computer is under repair.

### Important:

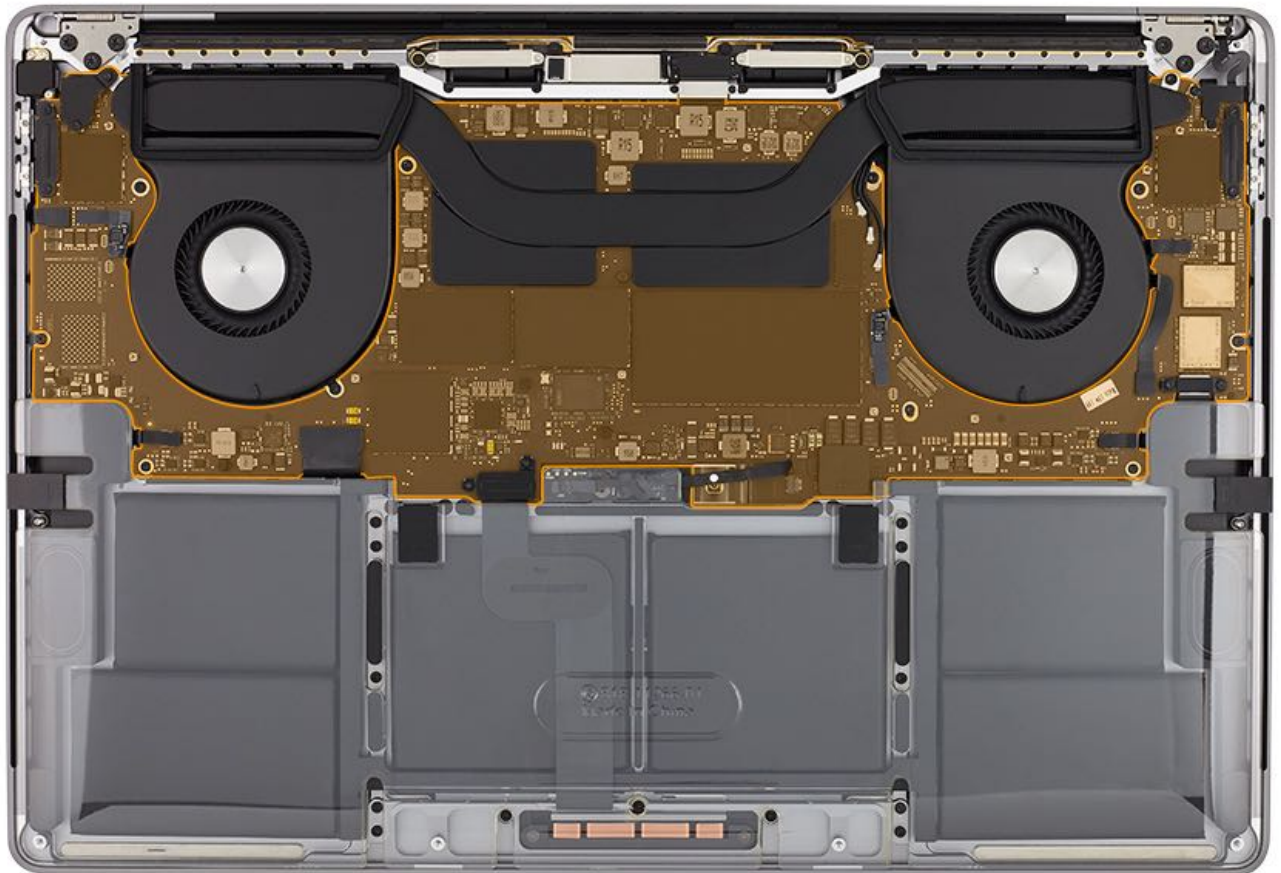
- Only Apple-certified technicians should perform this procedure. F
- Wear an ESD wrist strap and take precautions to avoid ESD.
- 

### Caution:

- This repair is not complete until System Configuration has been performed.

### Remove:

- [Bottom case](#)
- [Attach battery cover and disconnect battery](#)
- [Clutch covers](#)



## Tools

- Antenna removal tool

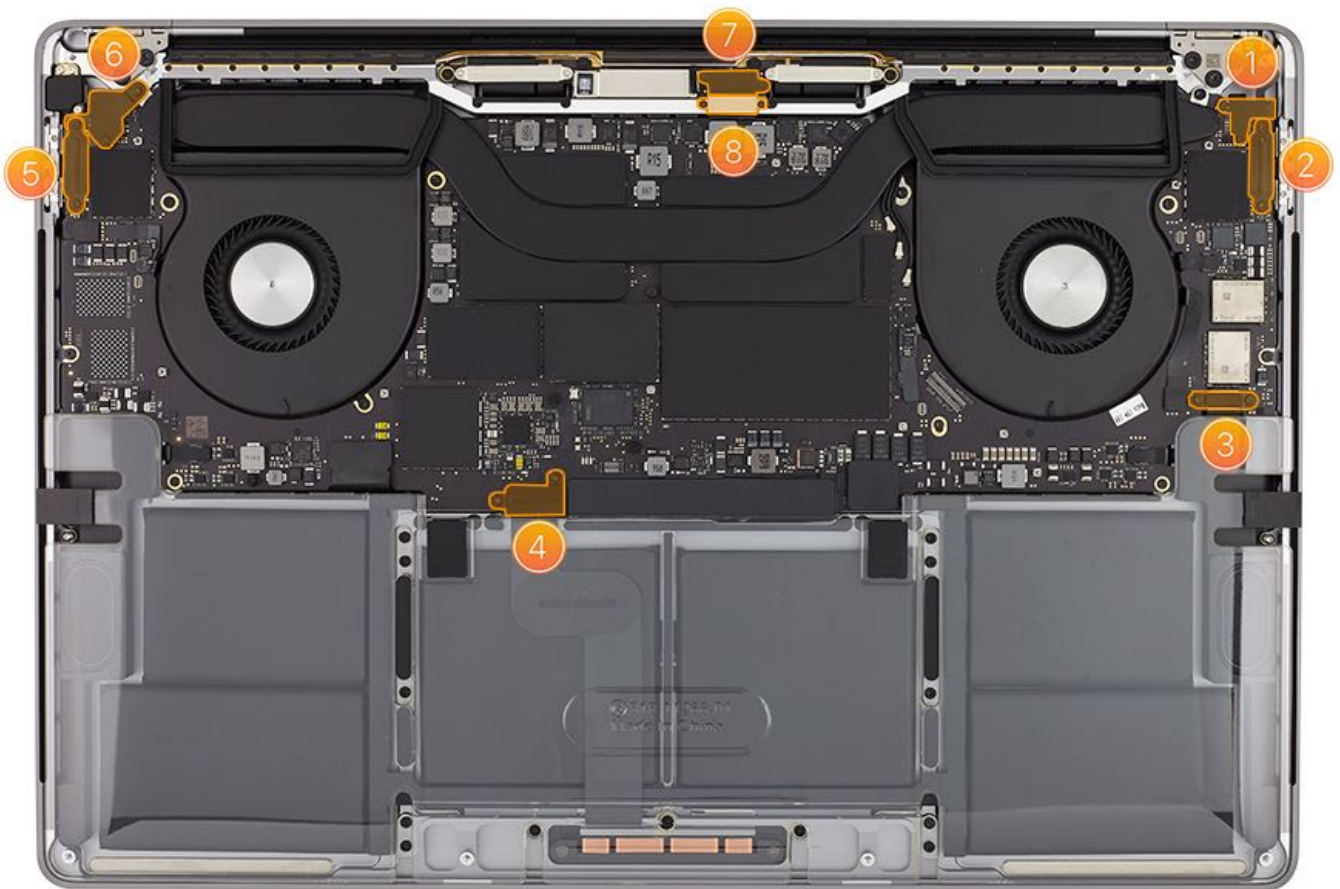


- Black stick
- Torx T3 screwdriver
- Torx T5 screwdriver
- Torx T8 screwdriver
- Phillips #00 (stiffener removal and replacement only)
- ESD-safe tweezers



## Steps For Removal

1. Remove the T3 screws from the cowlings marked below.

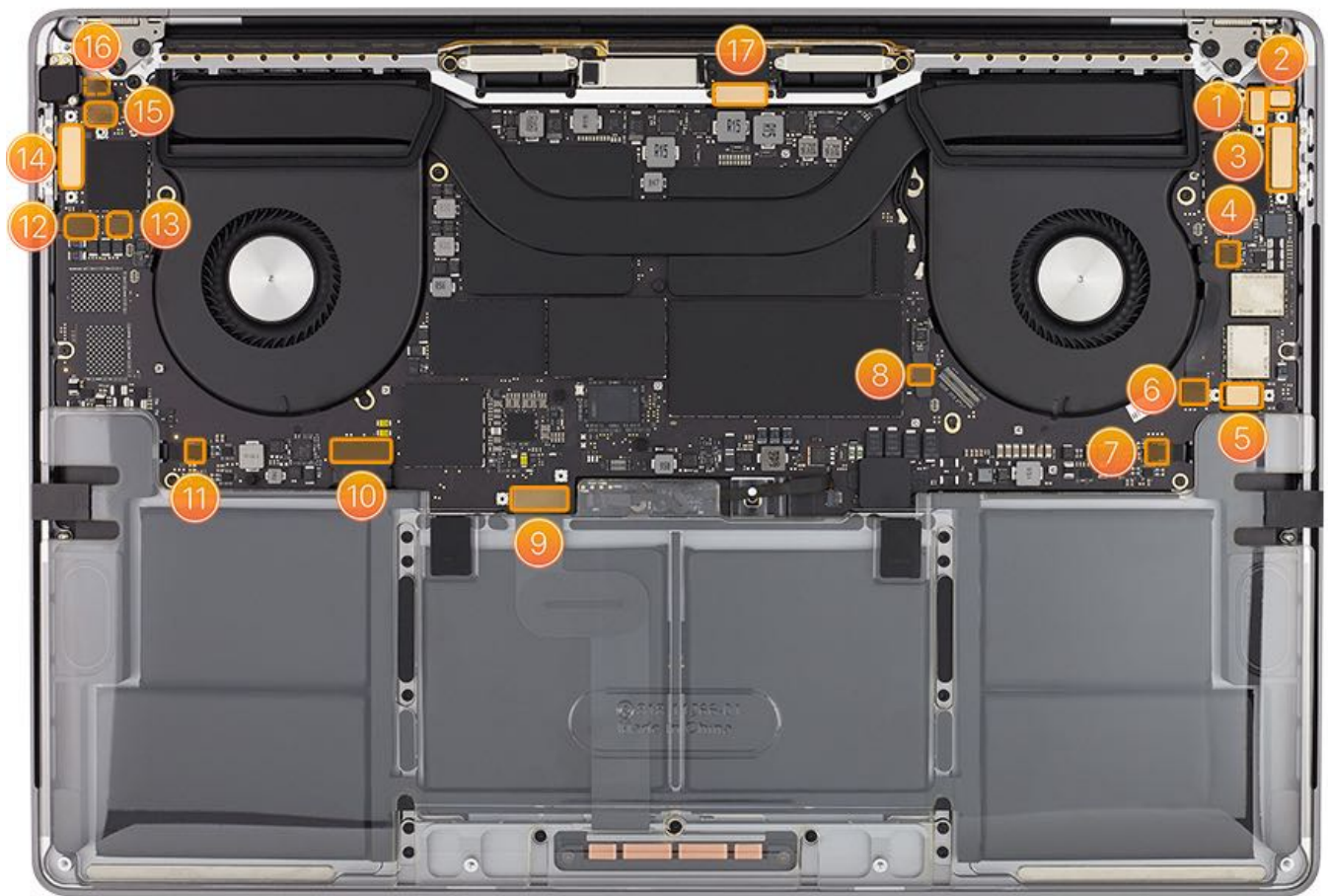


### Cowling Locations:

1. Lid Angle Sensor (LAS) flex/Touch Bar flex cowling
2. Left I/O board flex cowling
3. Touch Bar Display flex cowling
4. Trackpad flex cowling
5. Right I/O Board flex cowling
6. Touch ID flex and Audio Board flex cowling
7. Upper eDP flex cowling
8. Lower eDP flex cowling

2. Starting from the top left, move in a clockwise direction and disconnect the flex cables marked below:





#### Flex Connector Locations:

1. Touch Bar touch
2. LAS
3. Left I/O
4. Tri-Mic
5. Touch Bar display
6. Left keyboard backlight
7. Left speaker
8. Left fan
9. Trackpad
10. Keyboard
11. Right speaker
12. Right keyboard backlight
13. Right fan
14. Right I/O
15. Audio board
16. Touch ID board
17. eDP

#### Caution:

- Do not disconnect the Touch Bar display flex cable at either corner. Inserting a black stick at the corner can damage the connector on the logic board. Insert the black stick only in the center of the flex connector.
- Always disconnect the I/O flex cables from either side and not from the center. Inserting a black stick in the center of the flex connector can damage components within the connector on the logic board.
- The fan flex cables (#8 and #14) have a chip on them and are adhered to the logic board with adhesive. Use a black stick to carefully remove them from the board.

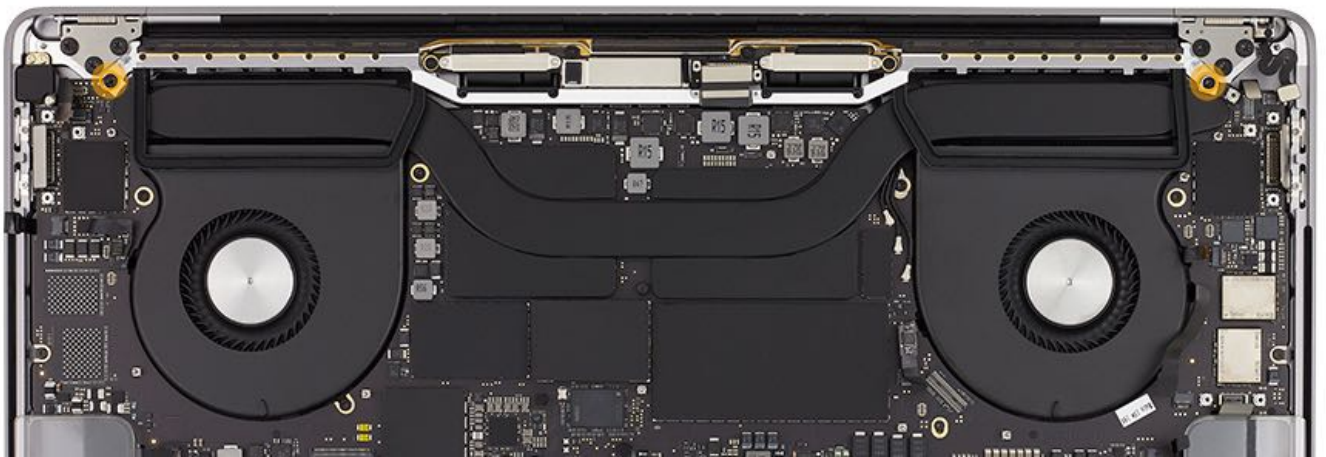
#### 3. Remove two T8 screws from the heat sink.

- T8: 923-01502 (left)

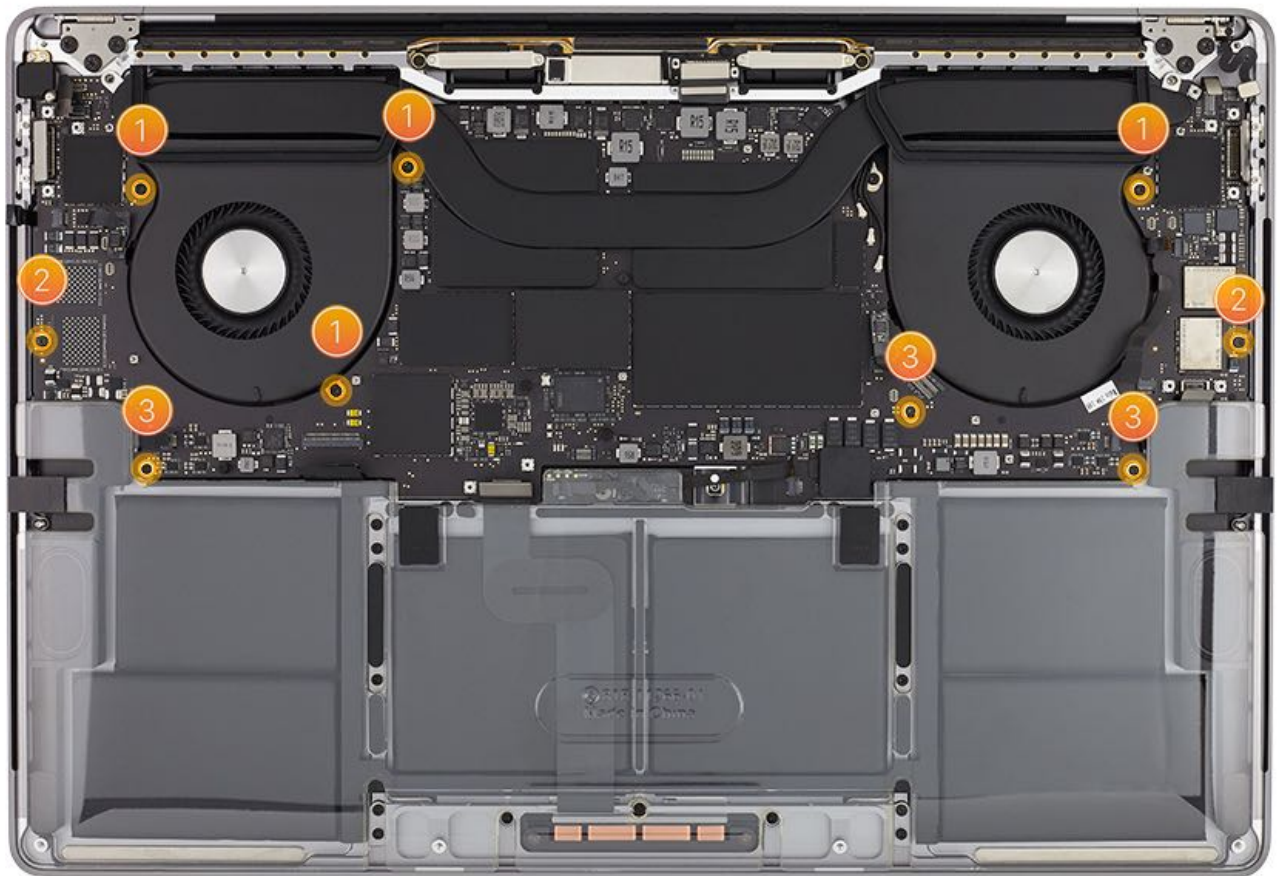


- T8: 923-01505 (right)

**Note:** The right screw is a screw within a screw.



4. Remove four T5 screws (1), two long T5 screws (2), and three T3 screws (3) from the logic board.



- T5 screws: 923-01500



- T5 screws (long): 923-03968



- T3 screws: 923-03913



5. Remove the T5 antenna grounding screw.

- T5: 923-01500

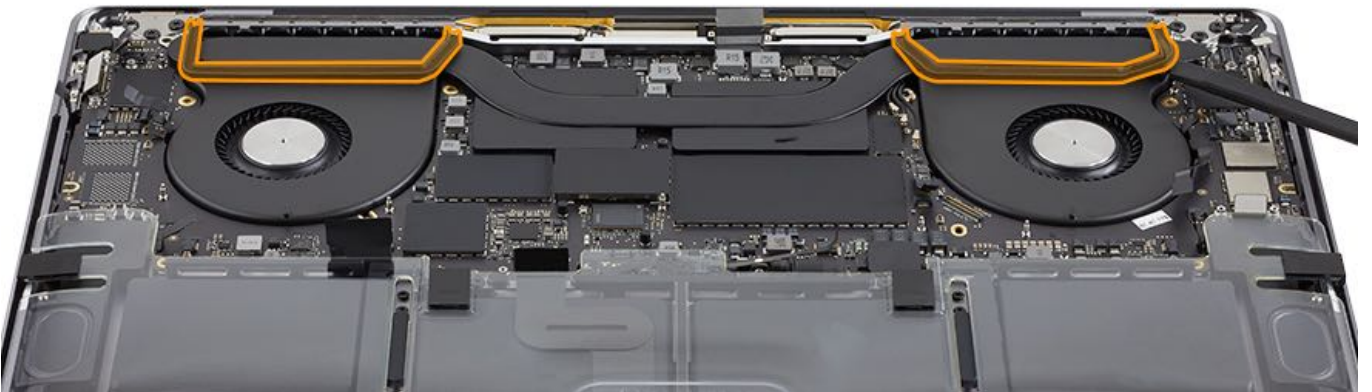


6. Use the antenna removal tool to disconnect the wireless and Bluetooth antennas.





7. Lift the thermal ducts up from, but not off of, the fans.



8. Use a black stick to gently lift the board up (1) and then holding the edges of the board, lift out (2) from the top case.





## Steps For Reassembly

**Note:** For reassembly, you can use Kapton tape to gently and lightly tape the flex cables out of the way to avoid pinching them under the logic board.

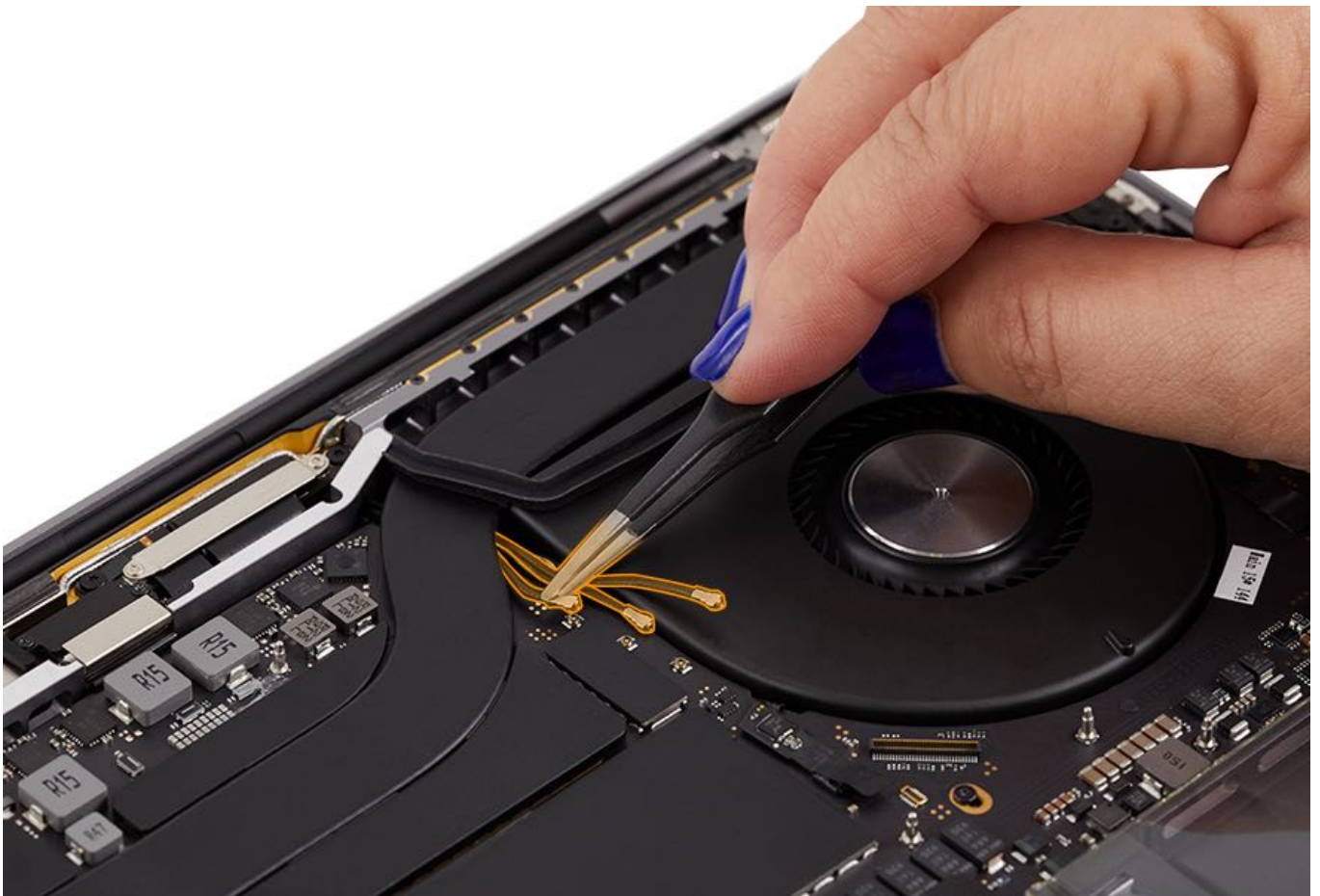
Reassemble in reverse order of removal steps.

**Caution:** Be sure no cables are caught under the logic board before attaching the antennas and screwing down the logic board. Bending the cables under the board can cause damage to the cables.

**Important:** If the logic board is replaced, the [Touch ID board](#) must also be replaced.

1. If you are installing a replacement logic board, remove the [eDP flex cable](#) from the known-bad board (KBB) logic board and transfer it to the new logic board.

2. When reconnecting the antennas, use tweezers to align the antenna head with the connector on the logic board. Then use the flip side of the antenna removal tool to make the connection.



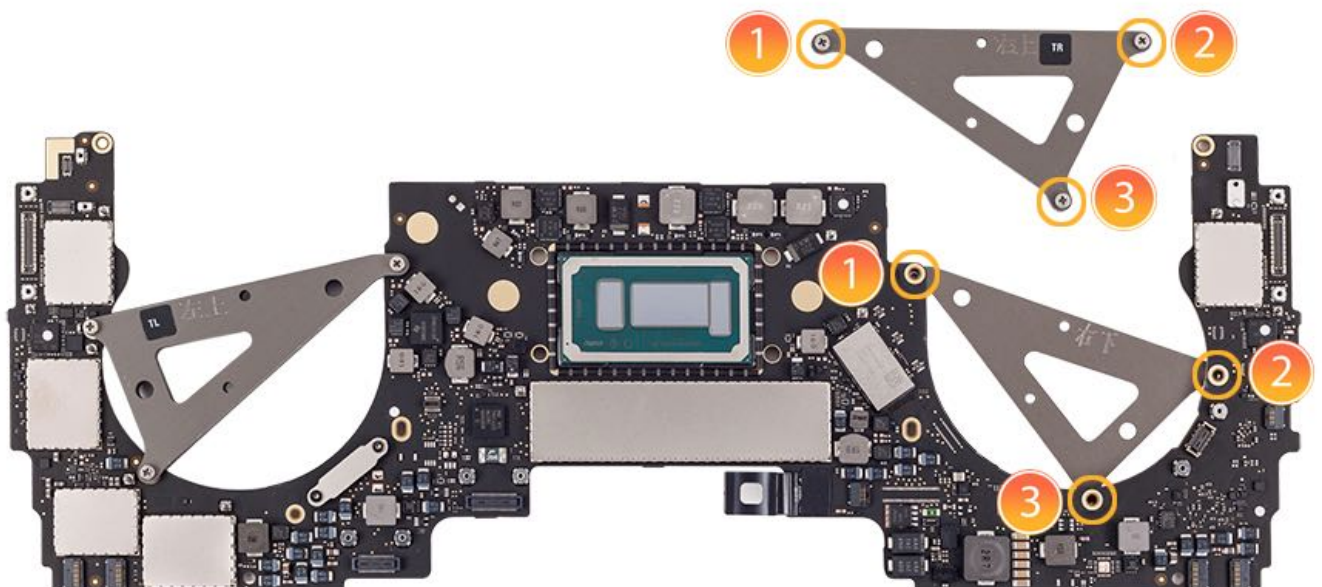
#### Returning the KBB logic board:

**Note:** The images shown are of a different MacBook Pro model, however the procedure is the same.

1. Transfer the two triangular stiffeners from the replacement logic board to the KBB board. **Note:** MacBook Pro (16-inch, 2019) has a triangular stiffener and a horizontal stiffener.

**Caution:** The stiffeners must be placed on the known-bad board before returning to Apple Service or the logic board may be damaged during shipping.

- Loosen the three Phillips #00 captive screws from the top of the stiffener.
- Separate the two halves of the stiffener and align them onto the known-bad board.
- Tighten the screws and repeat these steps for the other triangular stiffener.

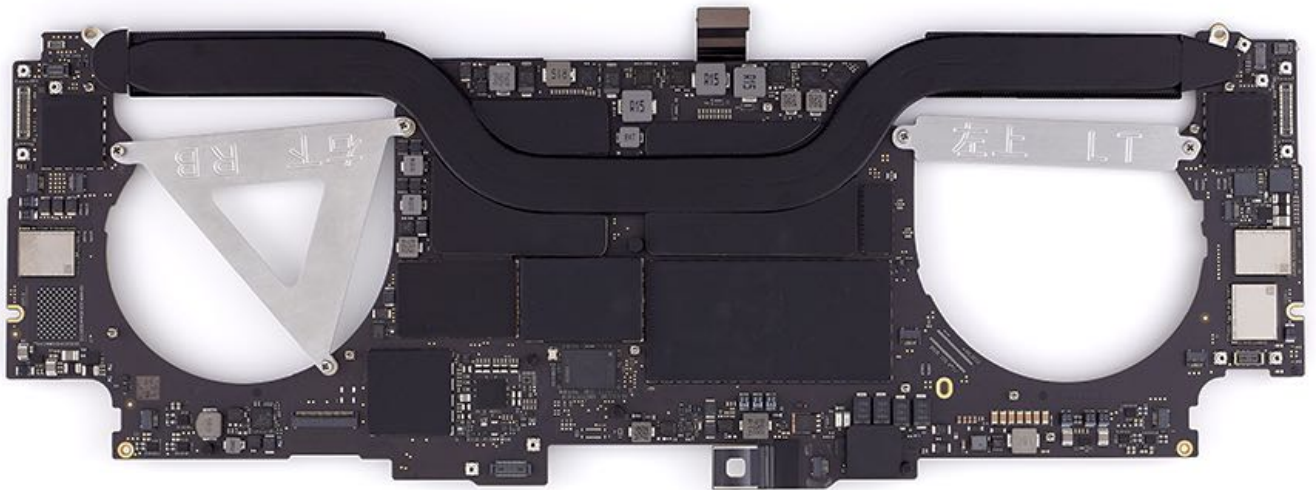
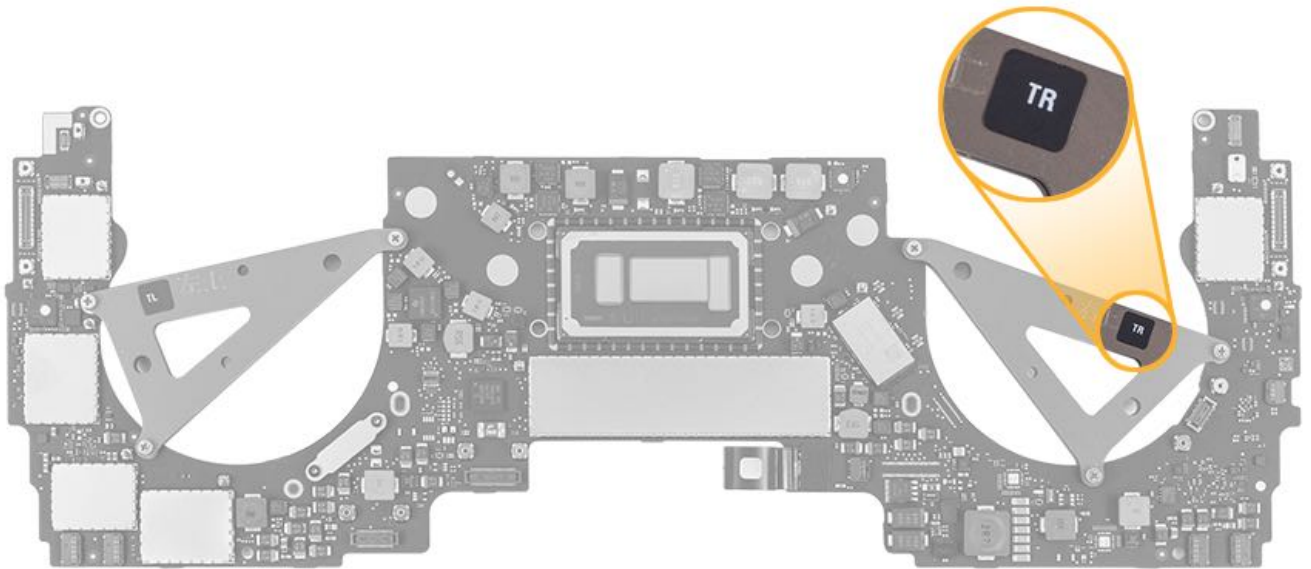


**Note:** The stiffeners have labels for position identification.

- TL-Top Left



- TR-Top Right
- BL-Bottom Left
- BR-Bottom Right



2. Reuse the packaging from the replacement board for the known-bad board:

- Place the known-bad board inside the reused ESD-safe bag.
- Position the bagged board in the foam frame.
- Close and seal the box, then return it to Apple Service.





3. Reinstall the [clutch covers](#).
4. Reinstall the [BMU screw, reconnect the battery flex cable, and remove the battery cover](#).
5. Reinstall the [bottom case](#).



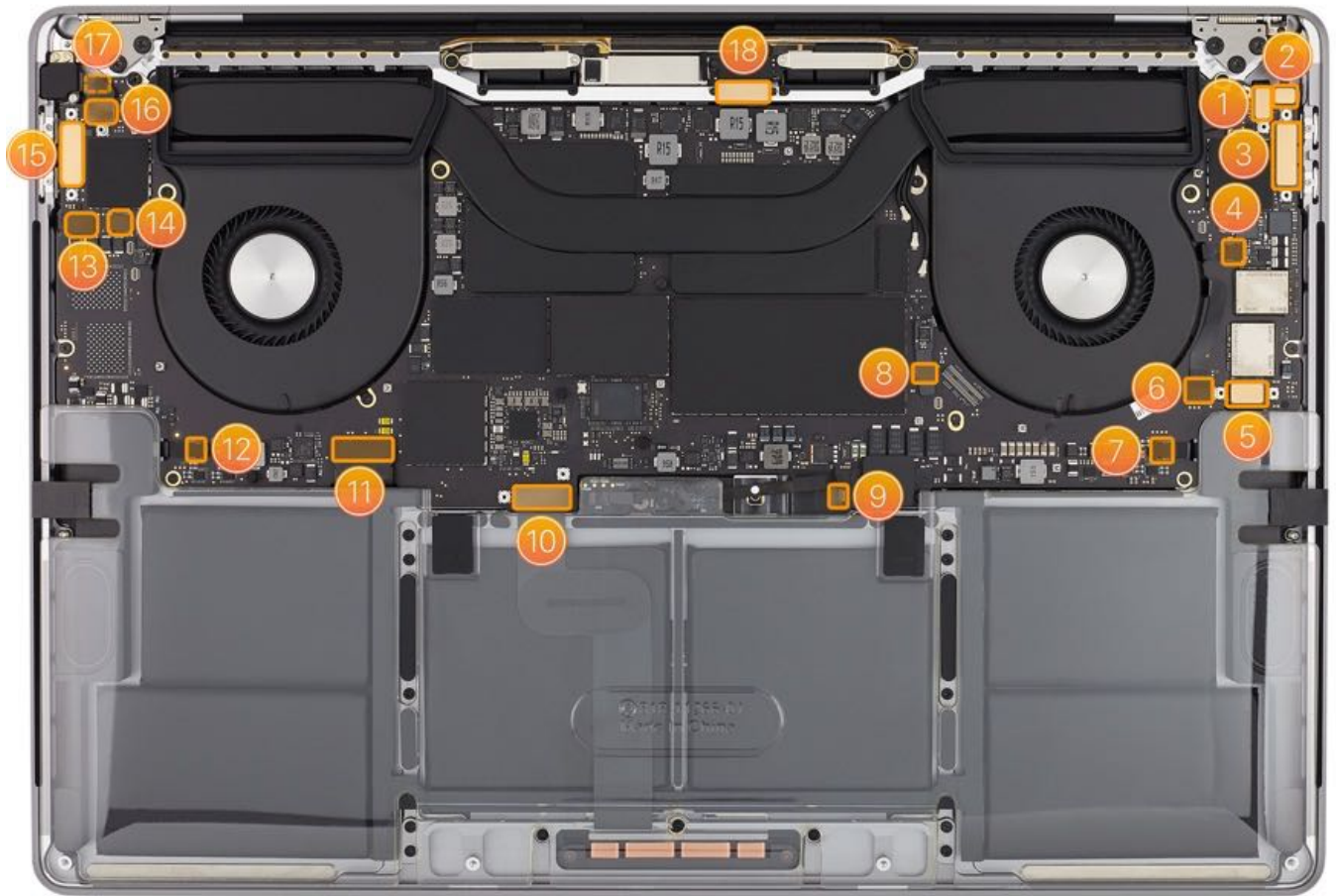
6. **Caution:**

- This repair is not complete until the System Configuration has been performed.

7. Follow the instructions in [Trackpad Calibration Check](#) to verify the trackpad performance after every repair.

# Connector Types on Logic Board

## Connector Types on Logic Board for MacBook Pro (16-inch, 2019)



### Low-Profile Solid Platform Flex

- Disconnect connector vertically in one motion. The connectors are susceptible to bent pins if rocked from side to side or inserted improperly.
- Reconnect connector by first aligning it over receptacle. Keep connector level with board and press down evenly.

#### Examples:

- 1 = Touch bar
- 2 = Lid Angle Sensor (LAS)
- 3 and 15 = Left and Right I/O
- 5 = Touch bar display
- 10 = Trackpad
- 16 = Audio board
- 17 = Touch ID board
- 18 = eDP

### Locking Lever

- Flip up lever 90 degrees and evenly disconnect cable.
- Lock down lever after inserting cable.
- Close lever when handling or shipping a logic board module, whether a known-good or a known-bad board.



**Caution:** The locking levers on the logic board are fragile. To protect the levers during handling or shipment of the logic board, close the levers after the cables are disconnected. Once the logic board is installed in the top case and the cables are connected, be sure to lock down the levers again.



Below are examples of components that have locking levers:

- 4 = Tri-Mic
- 6 = Left keyboard backlight
- 7 = Left speaker
- 8 = Left fan
- 9 = BMU
- 11 = Keyboard
- 12 = Right speaker
- 13 = Right keyboard backlight
- 14 = Right fan

# Reinstalling Software That Came with the Computer

## Reinstalling Software That Came with the Computer

This procedure requires an Internet connection.

**Note:** In some situations, a user may have set a firmware password. The user must know the firmware password in order to reinstall OS X or macOS.

**Important:** Apple recommends that users back up their data before any software restore procedure. Back up essential files before installing OS X or macOS. Apple is not responsible for any loss of data.

# Heat Sink

## First Steps



### Warning:

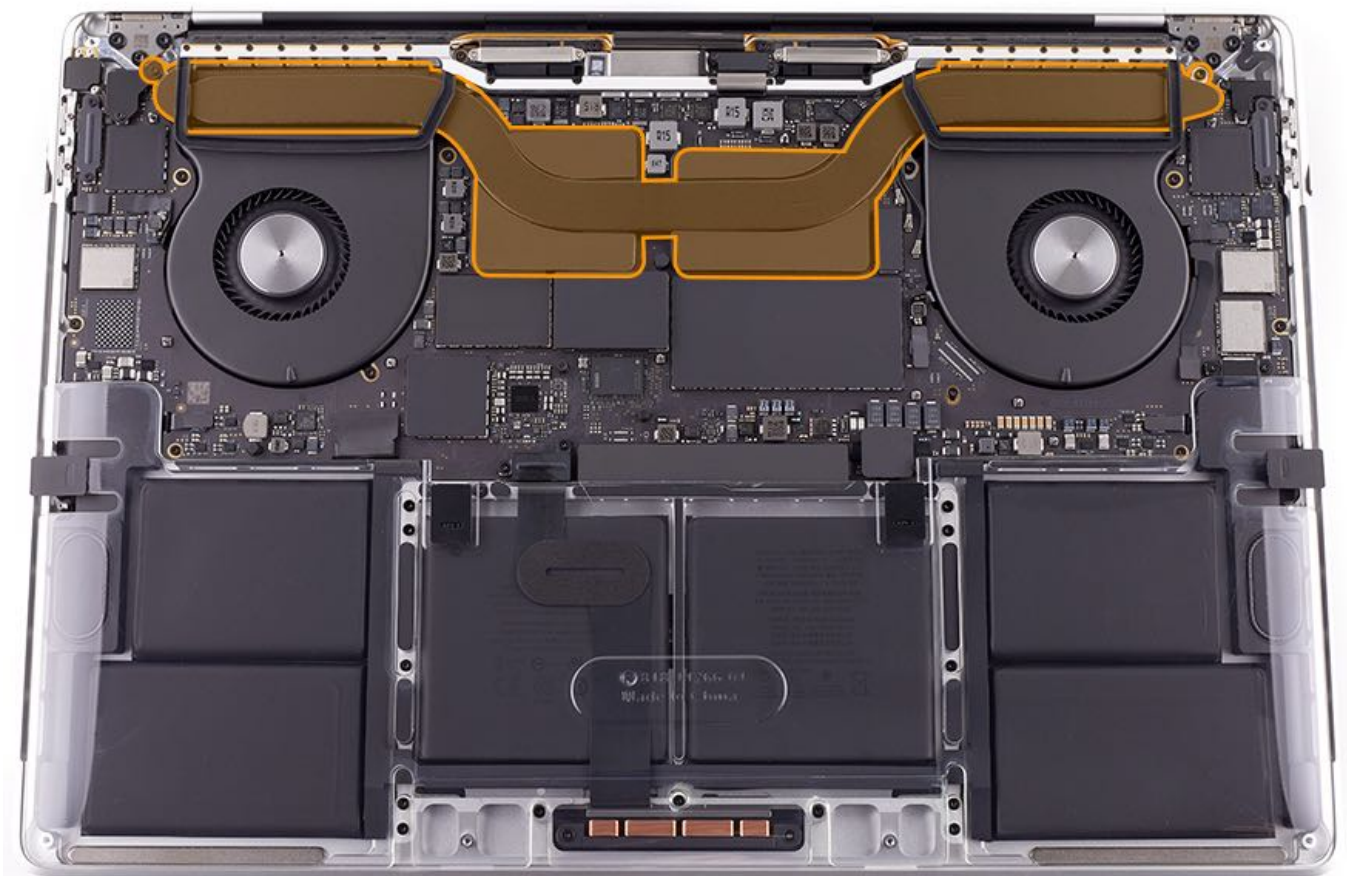
- To avoid damaging parts, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw before you begin a repair.
- Do not apply external power while the computer is under repair.

### Important:

- Only Apple-certified technicians should perform this procedure. Wear an ESD wrist strap and take precautions to avoid ESD.
- 

### Remove:

- [Bottom case](#)
- [Attach battery cover and disconnect battery](#)
- [Clutch covers](#)
- [Logic board](#)



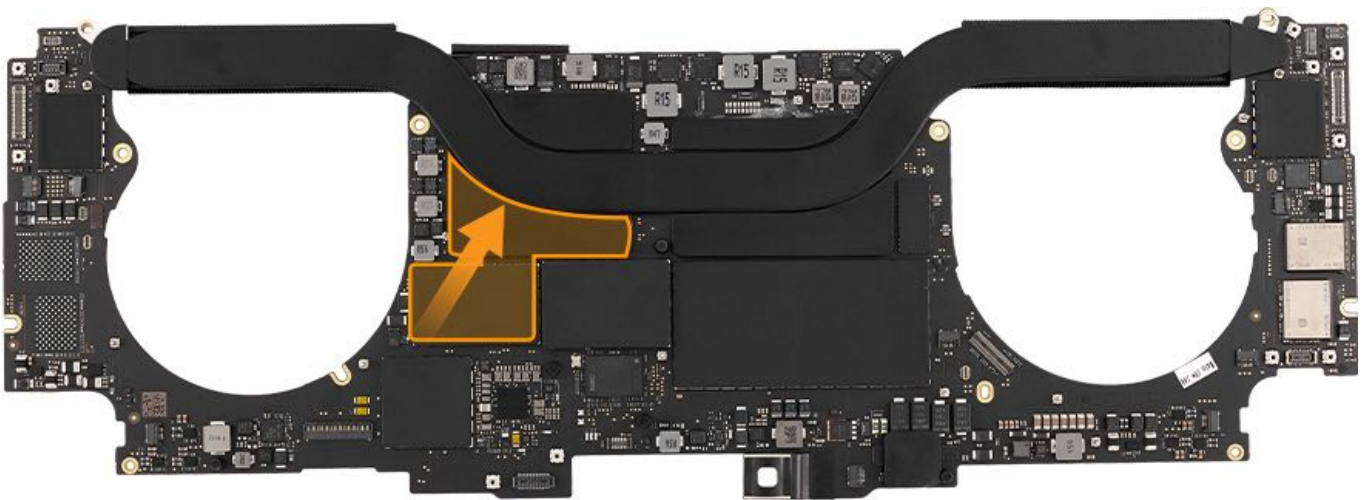
## Tools

- Torx T5
- Thermal grease syringe (922-7144)
- Isopropyl alcohol (IPA) wipes
- ESD-safe tweezers

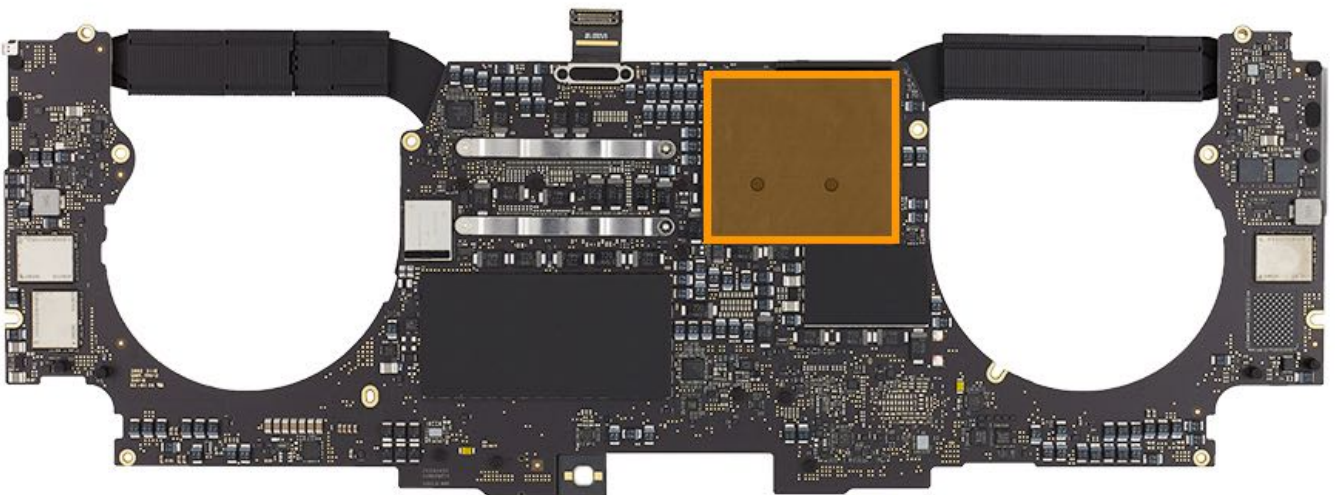


## Steps For Removal

1. Place the board on an ESD mat. Starting at the bottom corner, remove the thermal transfer material and Mylar from the logic board and the heat sink. These will come off as one piece but will be reassembled as two. **Note:** Do not save for reuse. A replacement heat sink will come with replacement transfer material and Mylar.



2. Turn over the logic board. Remove the Mylar covering the GPU flexures. **Note:** Do not save for reuse. A replacement heat sink will come with new Mylar.



3. Remove four T5 flexure screws from the CPU and four T5 flexure screws from the GPU.

- T5: Four 923-03971 (GPU)



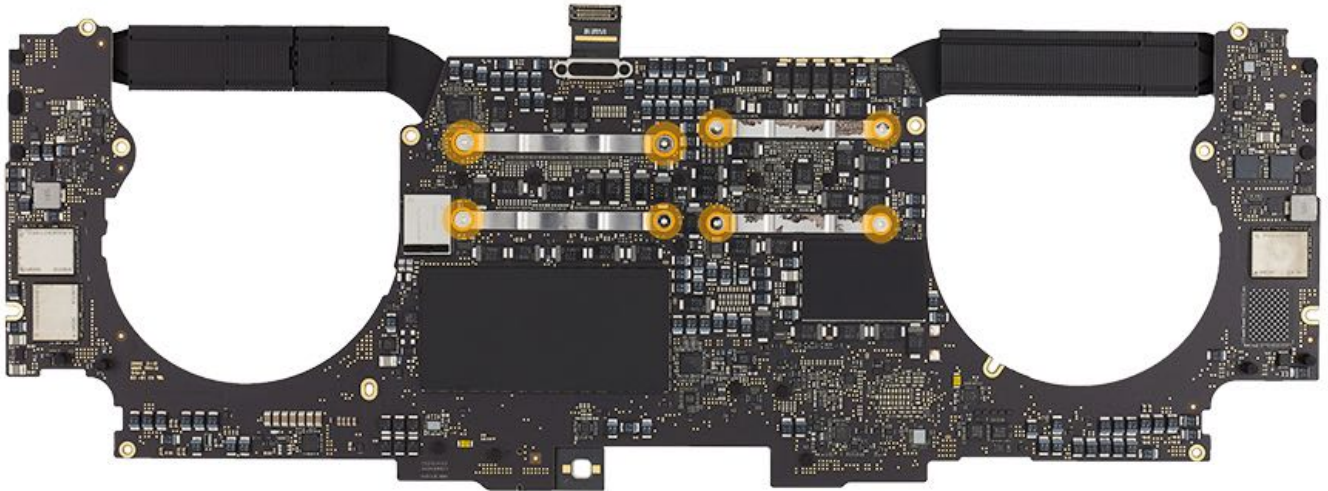
- T5: Four 923-03970 (CPU)





**Note:**

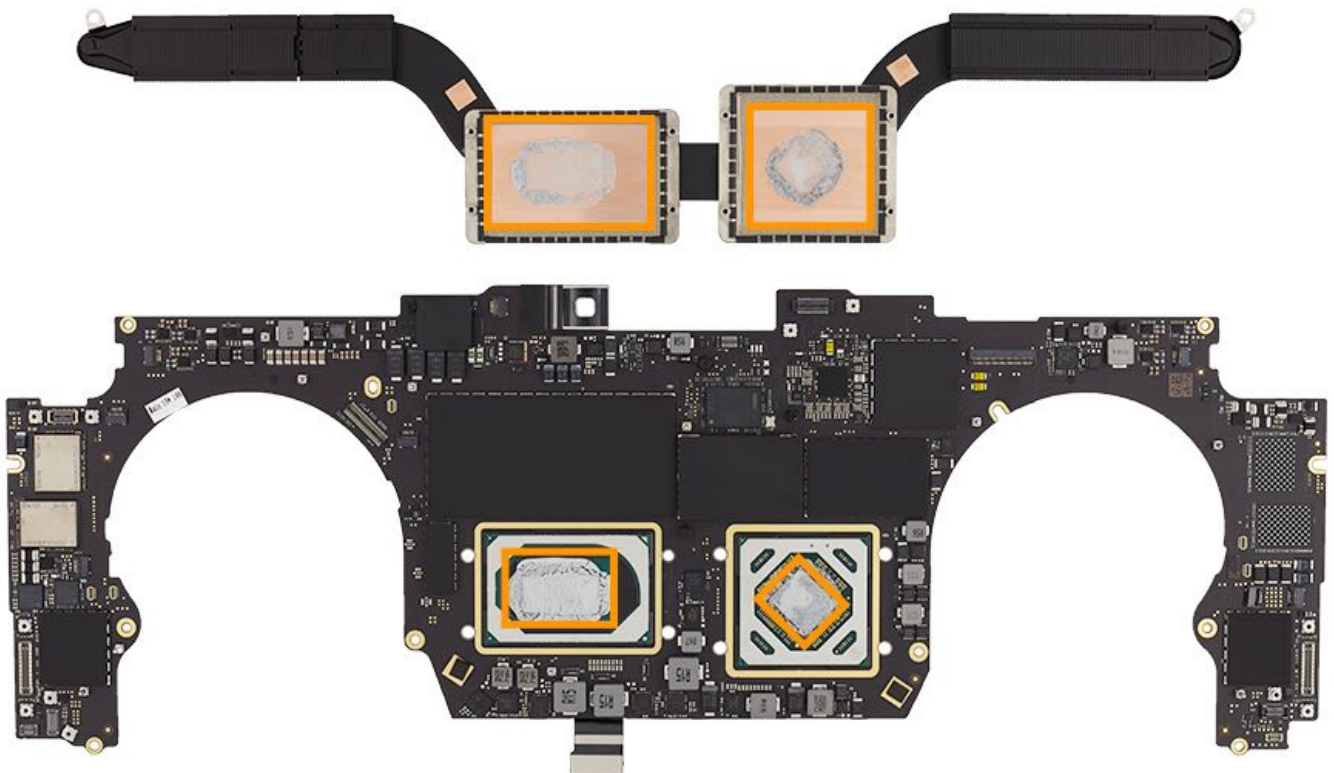
- The CPU flexures are longer than the GPU flexures.
- The heat sink flexures are under tension. Gently hold down the flexure when removing the screws on each flexure clip. Note the orientation of the flexure before removing and be sure to replace in the same orientation to ensure proper tension.



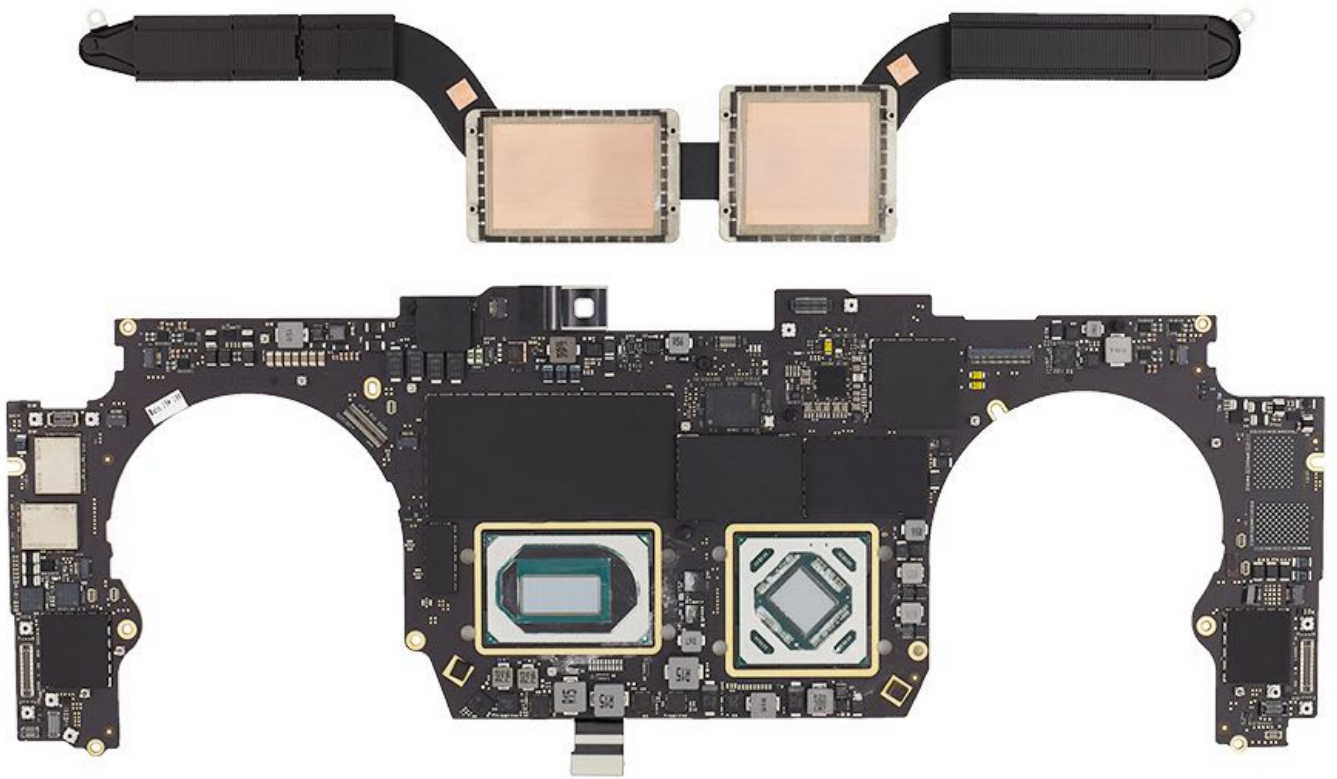
4. Gently lift the heat sink from the logic board. **Note:** Always hold the heat sink by the body. Never hold the heat sink by the arms.

5. Use IPA wipes to clean the thermal grease from the heat sink and processor chips.

**Before cleaning:**

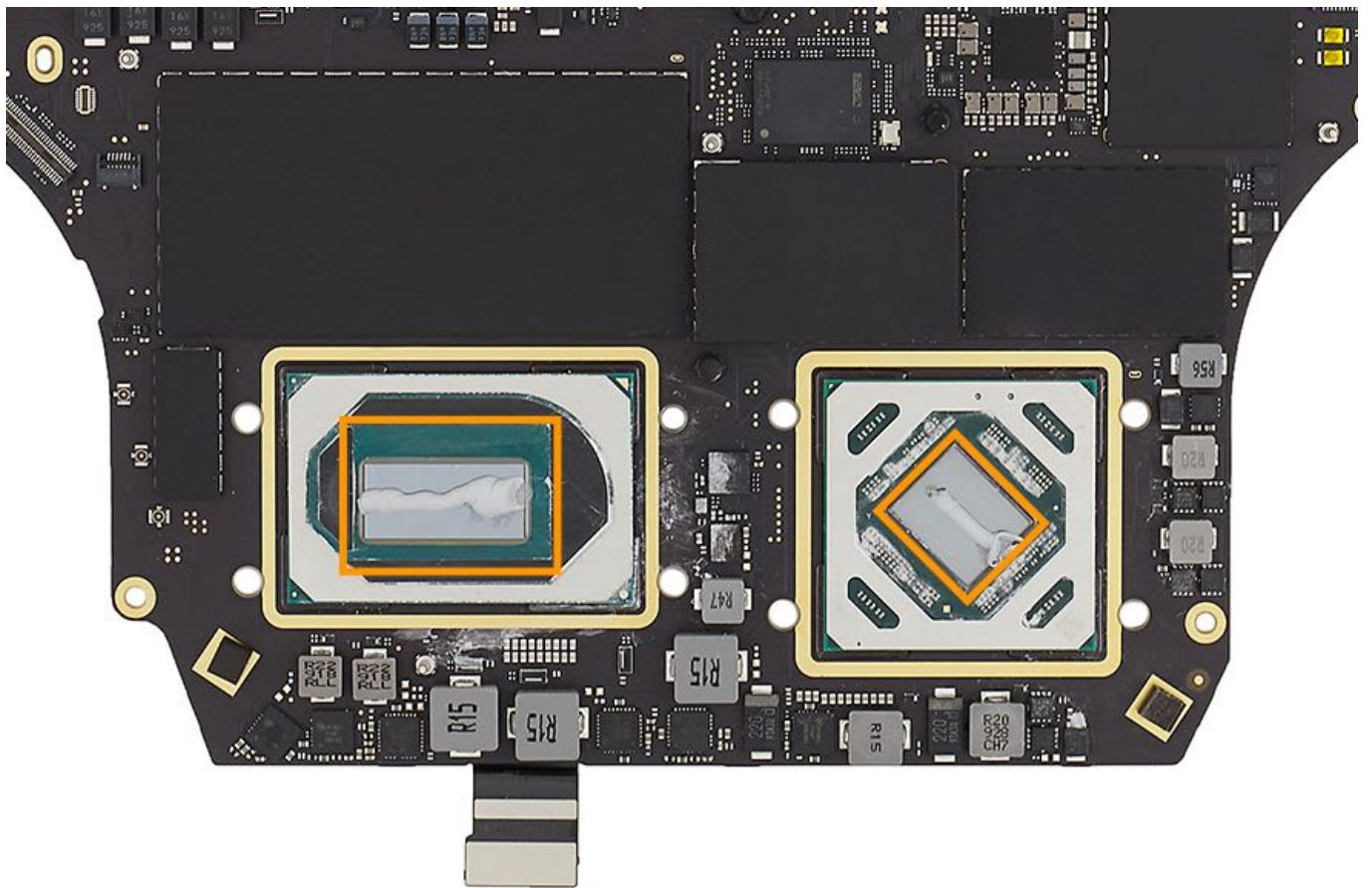


**After cleaning:**



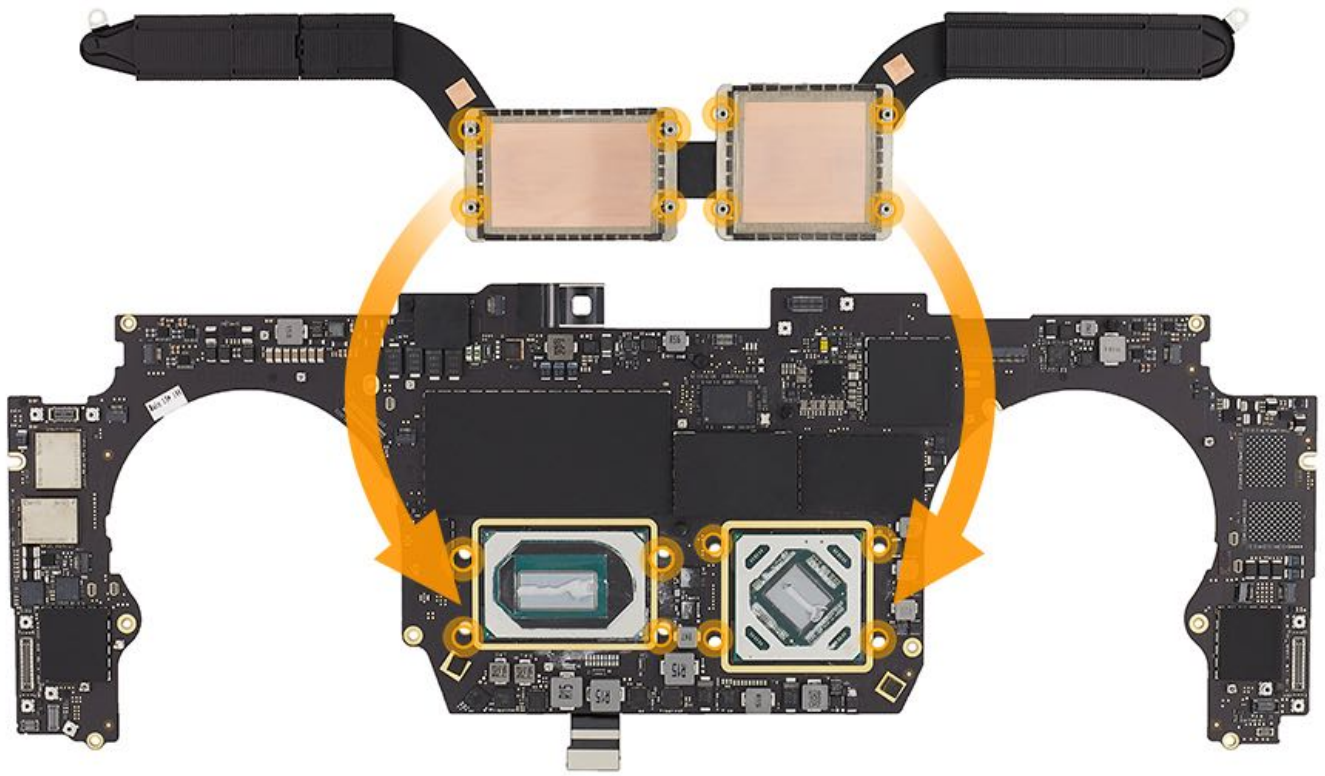
## Steps For Reassembly

1. Use the thermal paste syringe to inject half of the paste on each processor chip.



2. Carefully align the heat sink screw bosses with the screw holes on the logic board. Hold the heat sink in place as you carefully turn over the logic board to reinstall the screws.

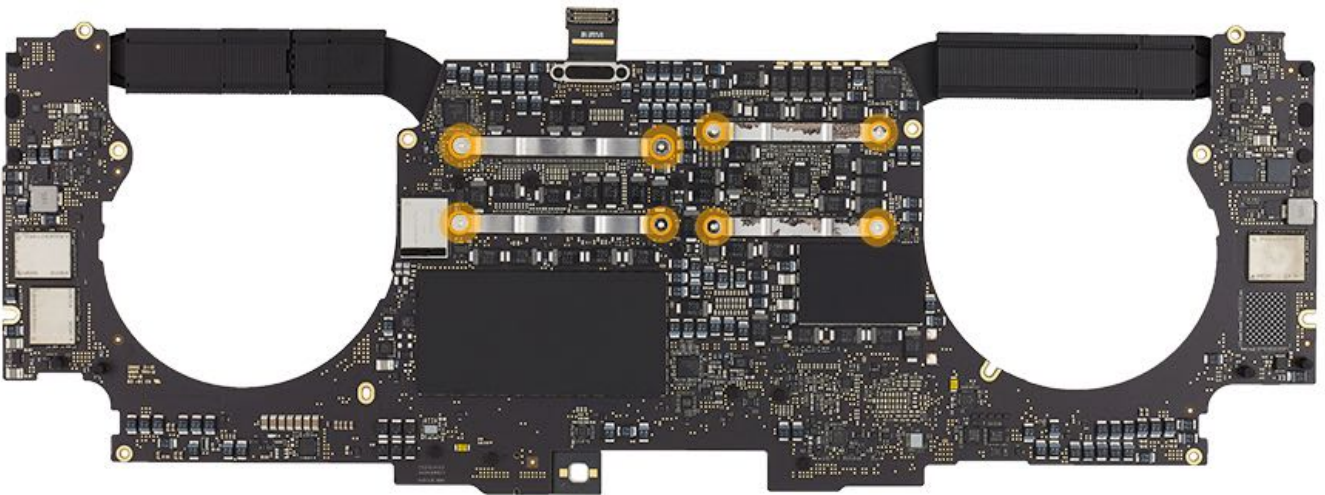




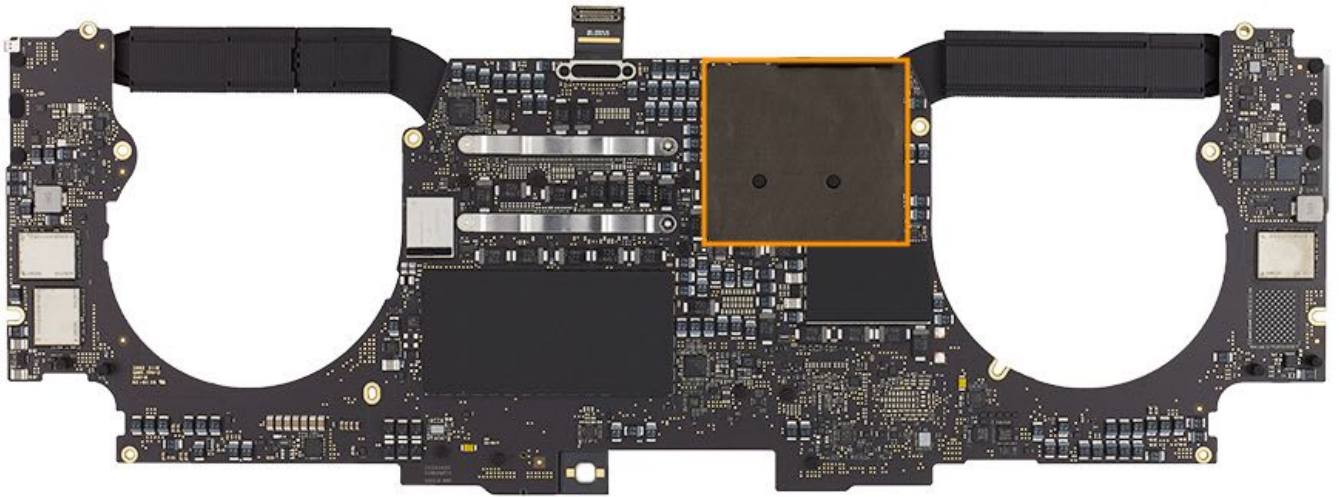
3. Reinstall the heat sink flexures and eight T5 heat sink screws.

**Note:**

- There are two sizes of flexures. Be sure to reinstall each one in the correct location.
- The heat sink flexures are under tension. Gently hold down the flexure when replacing the second screw on each flexure clip.
- Be sure the flexures are in the same orientation as before removal.

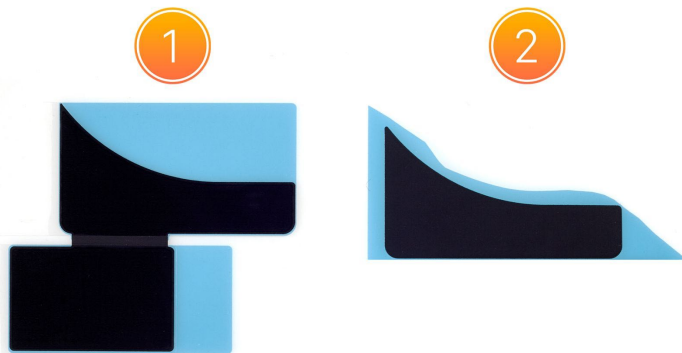


4. Reinstall the Mylar over the GPU flexures.

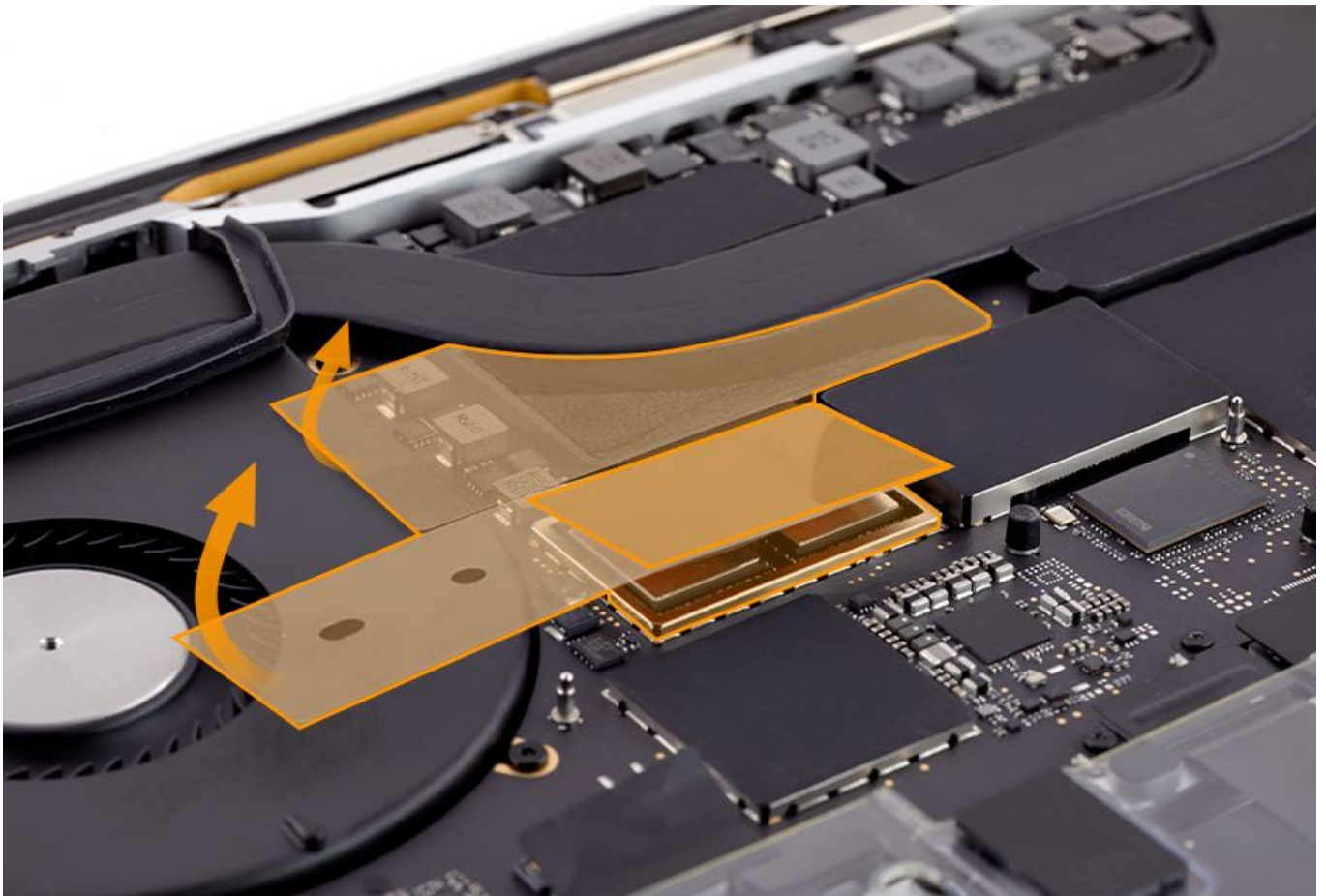


5. Reinstall the [logic board](#).

6. Install the thermal transfer material (1) and the Mylar (2).

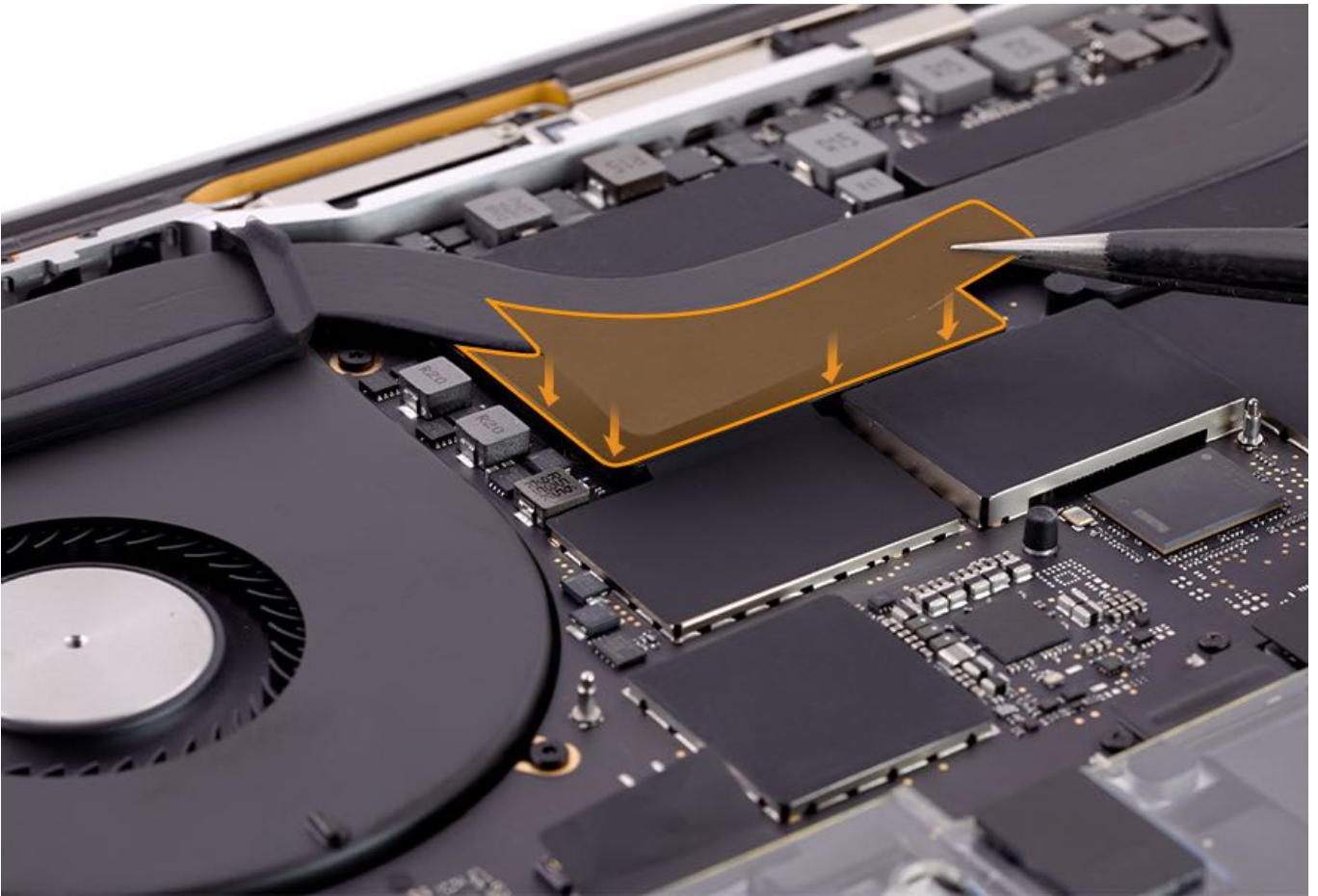


7. Align the curve of the thermal transfer material with the curve in the heat sink and lay it flat. Then continue to fit the tape onto the VRAM on the logic board. Lift off the plastic tabs and press the tape down with your fingers to secure it.





8. Align the curve of the Mylar with the curve of the heat sink and smooth it down on top of the first piece of tape. **Caution:** The thermal transfer material and Mylar must be replaced in this order for the heat to dissipate properly.



9. Reinstall the [clutch covers](#).
10. Reinstall the [BMU screw, reconnect the battery, and remove the battery cover](#).
11. Reinstall the [bottom case](#).
12. Follow the instructions in [Trackpad Calibration Check](#) to verify the trackpad performance after every repair.

# Embedded DisplayPort (eDP) Flex Cable

## First Steps



### Warning:

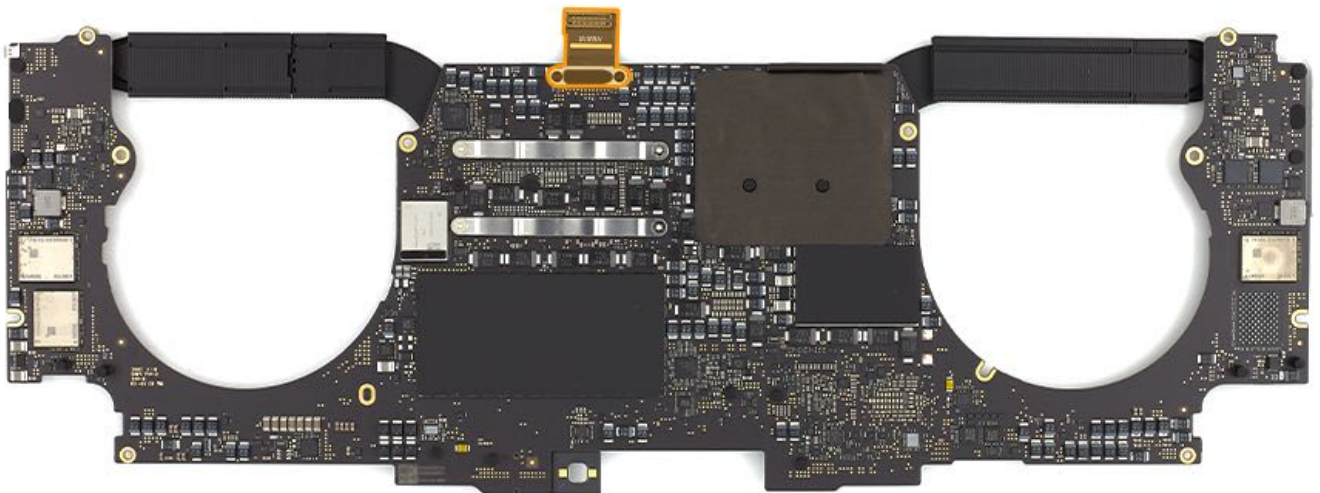
- To avoid damaging parts, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw before you begin a repair.
- Do not apply external power while the computer is under repair.

### Important:

- Only Apple-certified technicians should perform this procedure. Wear an ESD wrist strap and take precautions to avoid ESD.
- 

### Remove:

- [Bottom case](#)
- [Attach battery cover and disconnect battery](#)
- [Clutch covers](#)
- [Logic board](#)



## Tools

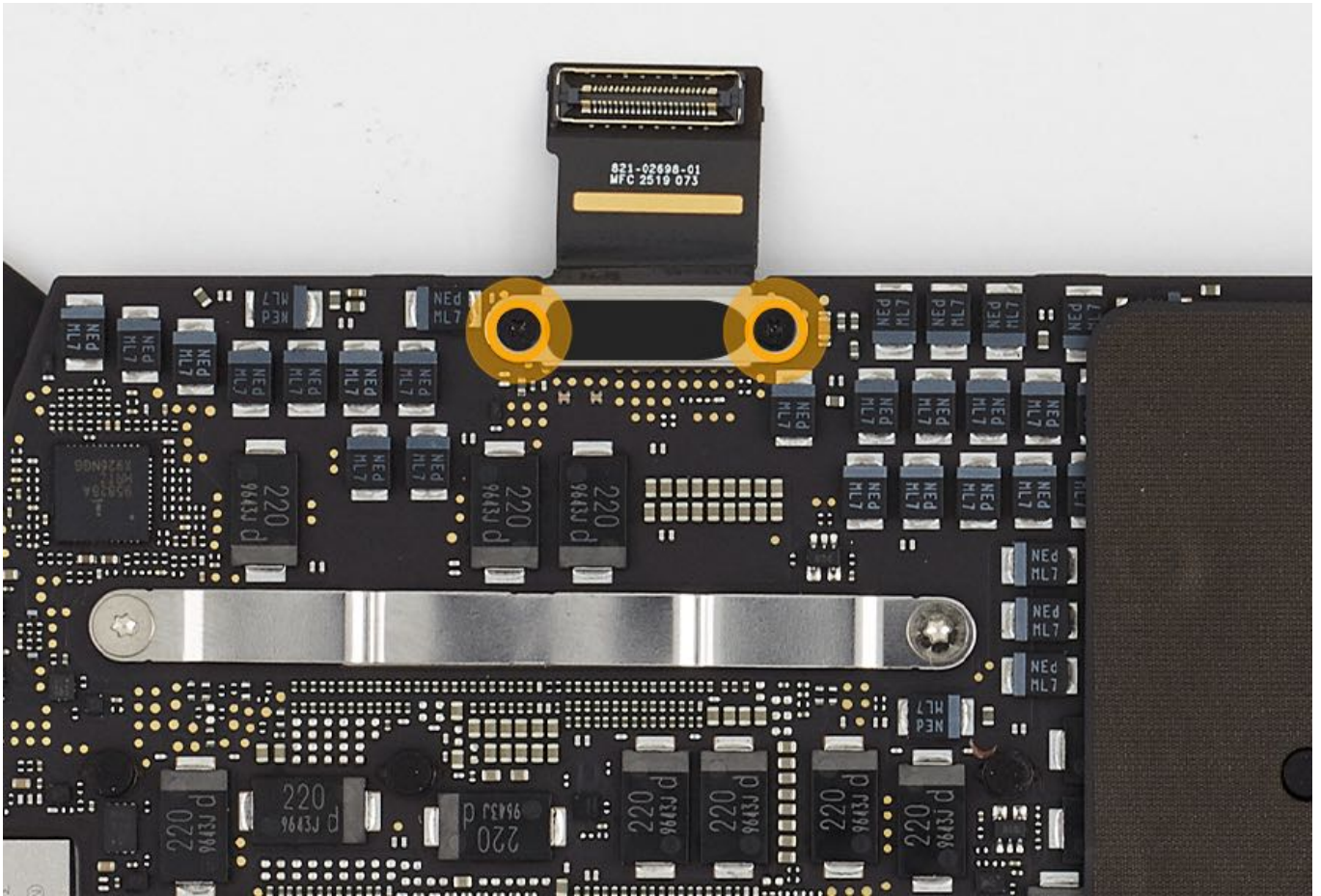
- Torx T3 screwdriver
- Black stick



## Steps For Removal

1. Turn the logic board over.
2. Remove two T3 screws from the eDP flex cable cowling.

- T3: 923-03972



3. Use a black stick to disconnect the eDP flex cable from the logic board.

### Steps For Reassembly

1. Reassemble in reverse order of removal steps.
2. Reinstall the [logic board](#).
3. Reinstall the [clutch covers](#).
4. Reinstall the [BMU screw, reconnect the battery, and remove the battery cover](#).
5. Reinstall the [bottom case](#).
6. Follow the instructions in [Trackpad Calibration Check](#) to verify the trackpad performance after every repair.

# Vent/Antenna Module

## First Steps



### Warning:

- To avoid damaging parts, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw before you begin a repair.
- Do not apply external power while the computer is under repair.

### Important:

- Only Apple-certified technicians should perform this procedure.  
Wear an ESD wrist strap and take precautions to avoid ESD.
- 

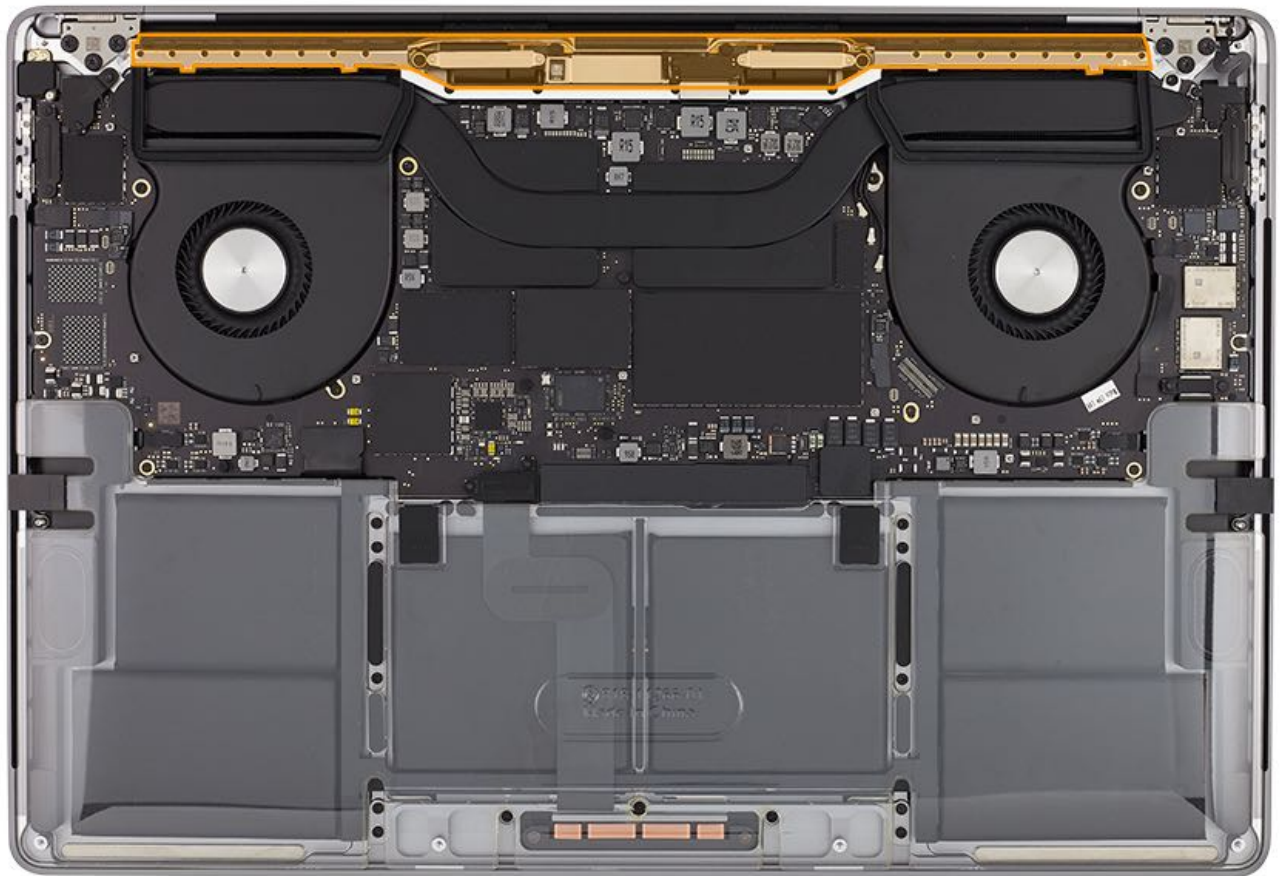
### Remove:

- [Bottom case](#)
- [Attach battery cover and disconnect battery](#)
- [Clutch covers](#)

To get a better idea of what you are removing and replacing, see the image of the vent/antenna module below:







## Tools

- Antenna removal tool, optional (923-01322)
- Black stick
- Torx T3 screwdriver (magnetized)
- Torx T5 screwdriver (magnetized)
- Torque screwdriver (blue), 0.65kgf-cm (923-0448)
- Torx security bit (923-0247)
- ESD-safe plastic or nylon tweezers



## Steps For Removal

1. Remove the two T3 screws on the upper Embedded DisplayPort (eDP) flex cable cowling (1), the two T3 screws from the lower eDP flex cable cowling (2), and then disconnect the eDP flex cable.

- T3: 923-01285 (upper)



- T3: 923-01510 (lower)



2. Remove the T5 antenna grounding screw from the logic board.

- T5: 923-01500





3. Use the antenna removal tool to disconnect the antenna cables from the logic board.



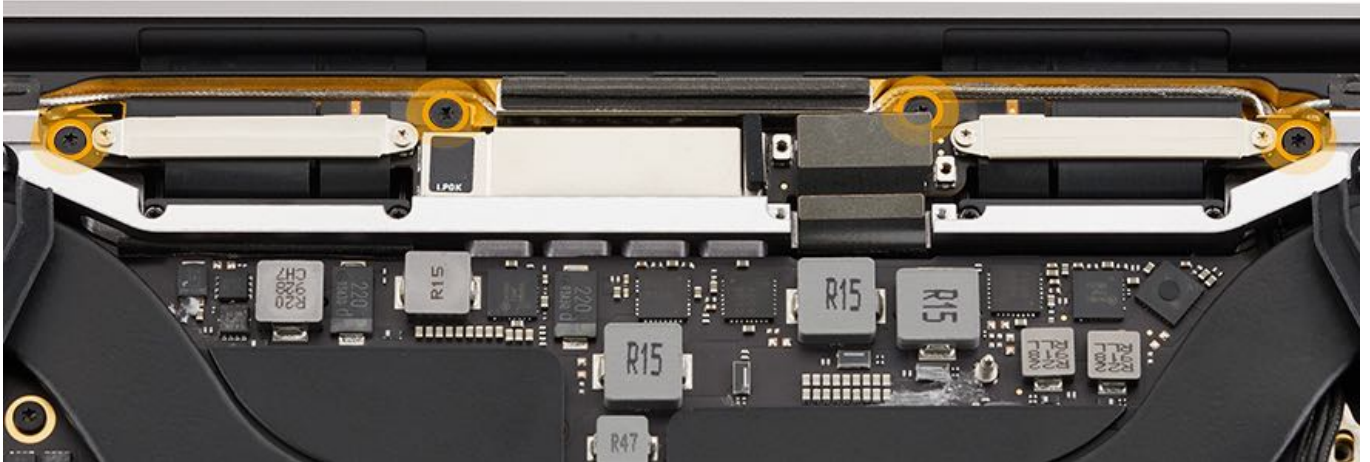
4. Remove the four T5 TCON screws.

- T5: 923-01277



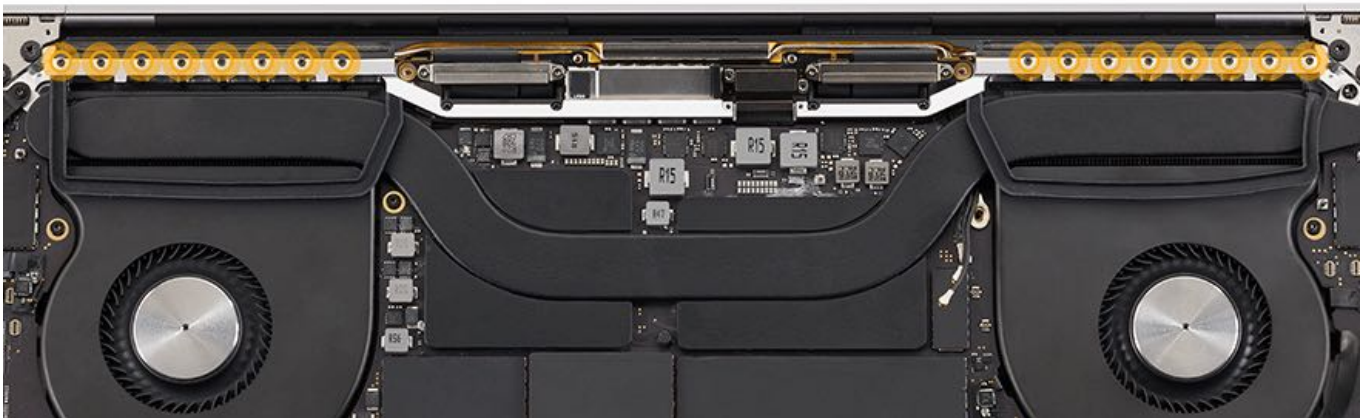


**Note:** The TCON board is part of the display assembly. Once the four TCON screws are removed, the TCON will release and the vent/antenna module can be accessed.



5. Remove the 16 1IPR vent/antenna screws with the torque screwdriver and Torx security bit. **Note:** Use a magnetized screwdriver to remove and reinstall the very small screws.

- 1IPR: 923-01512

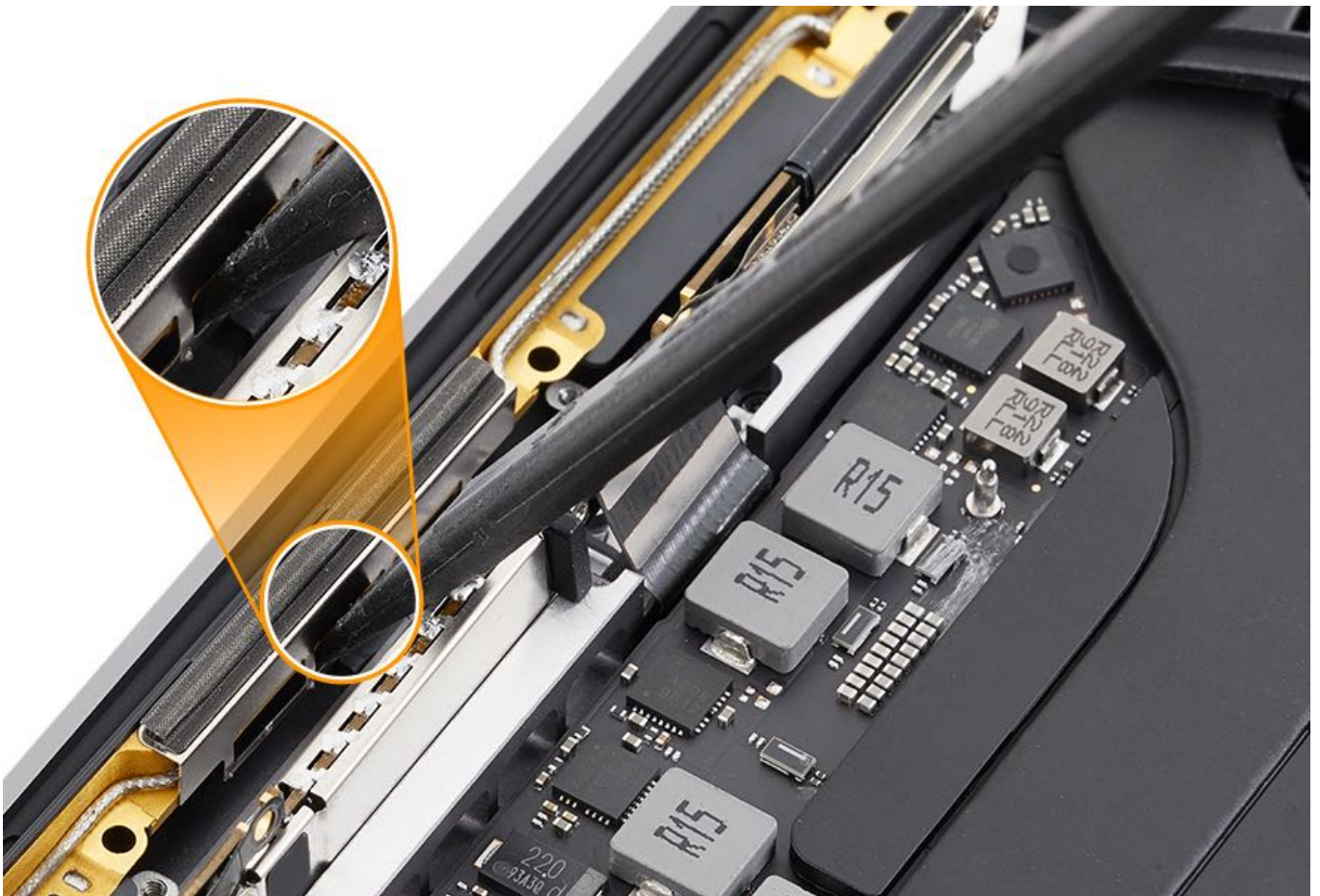


6. Find the middle slot in the vent/antenna module and gently insert a black stick in the slot to raise the vent/antenna module out of the top case. The vent/antenna module will make an audible click when released.

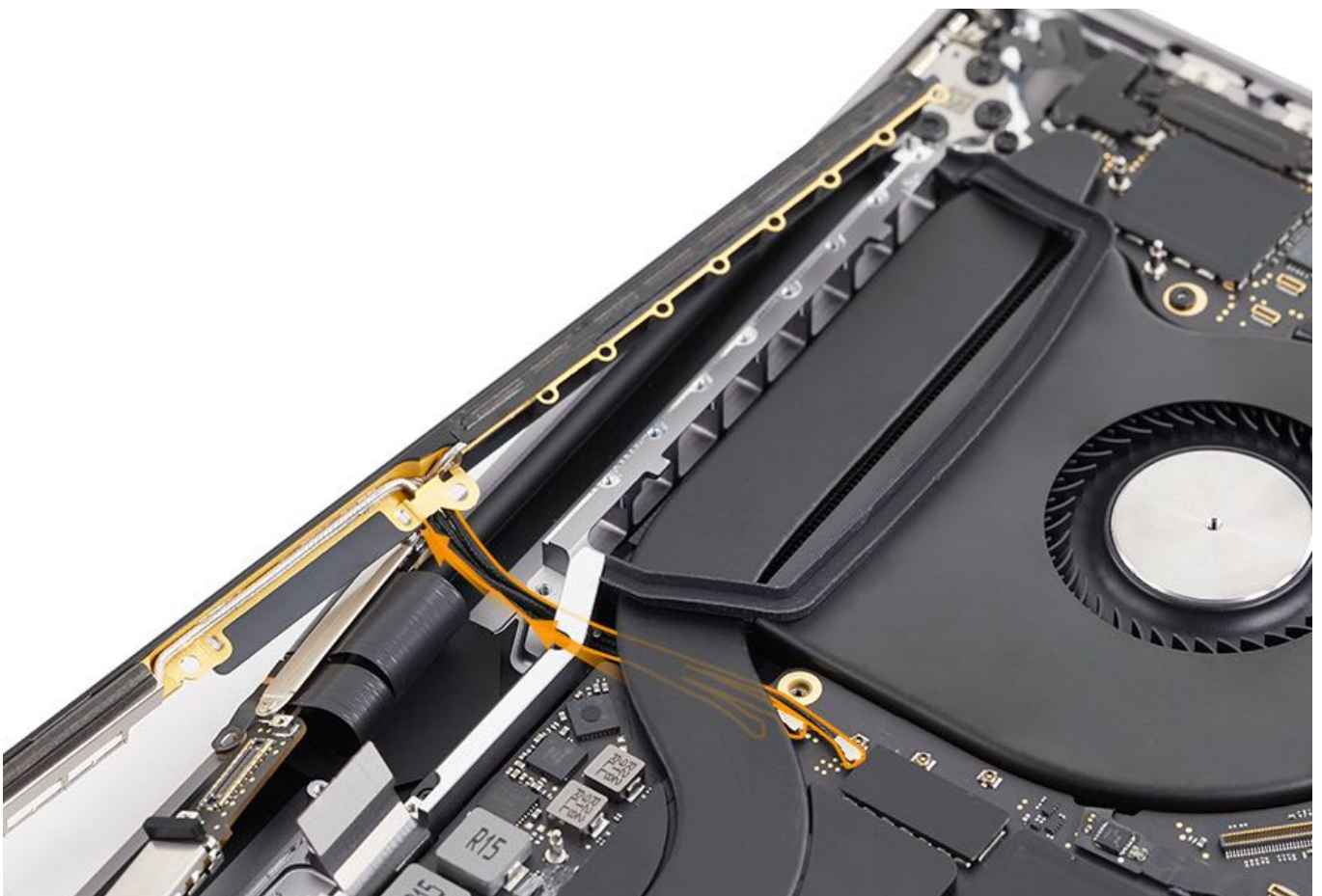
**Caution:**

- Be careful not to put pressure on the eDP flex cable.
- Support the vent/antenna module with your other hand to prevent it from bending as you take it out of the top case.





7. Route the antenna ground clip and three antennas through the opening in the rear wall. Be careful not to damage the wireless cables.

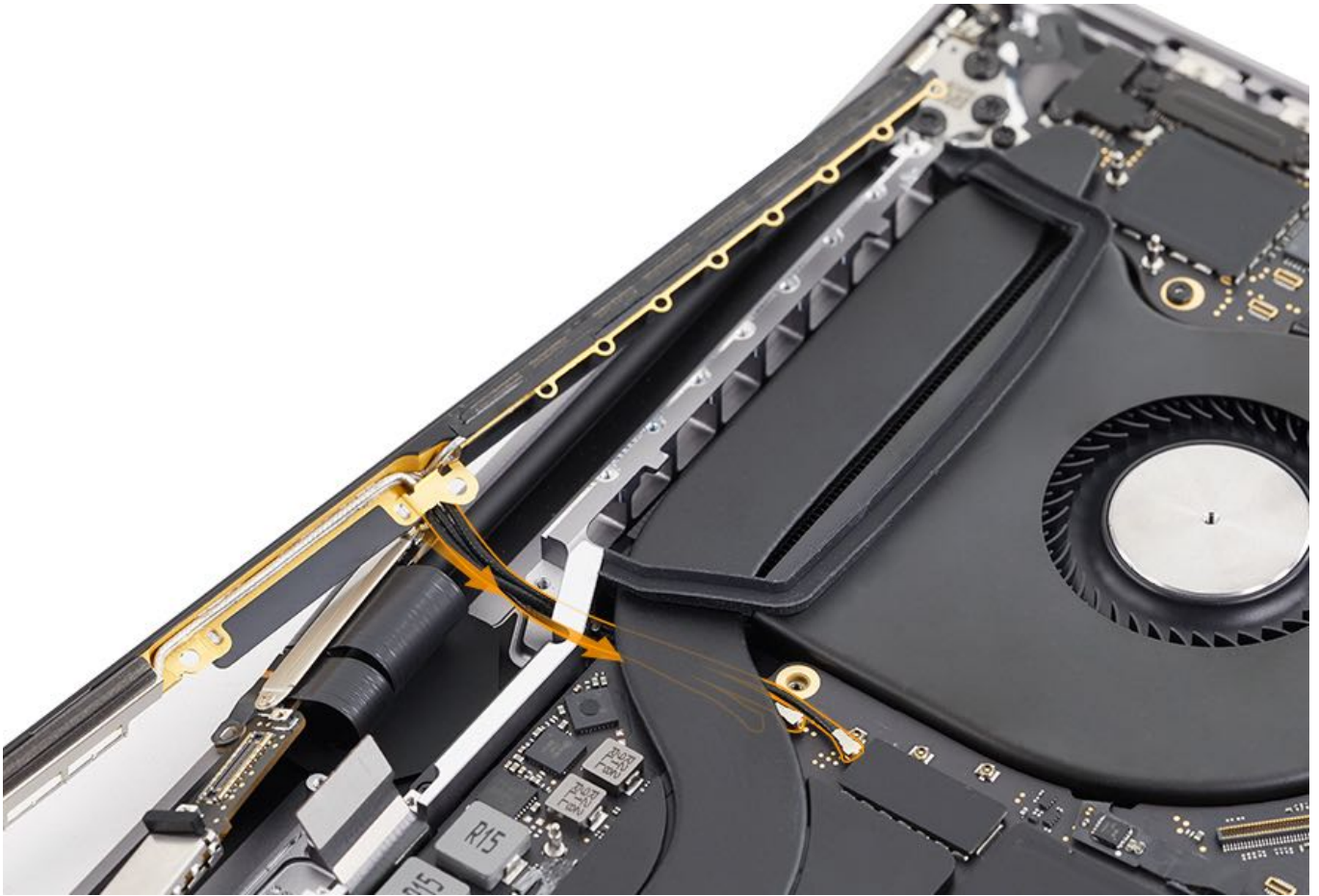


### Steps For Reassembly

1. Use tweezers and/or black stick to route the three antennas and ground clip through the opening in the rear wall and over

the logic board. Make sure the three cables are side by side, not overlapping.

**Note:** Some replacement vent/antenna modules include a removable sleeve to protect the antenna cables during shipment. The sleeve can stay on the cables while the cables are rerouted into the top case. However, remove the sleeve when the cables are positioned over the logic board.



2. Align the vent/antenna module in the top case and gently press down in the middle of the module until it makes an audible click.

3. Reconnect the antennas and reinstall the T5 antenna ground screw (923-01500).

**Note:** When reconnecting the antennas, use tweezers to align the antenna head with the connector on the logic board. Then use the opposite side of the antenna removal tool to make the connection.

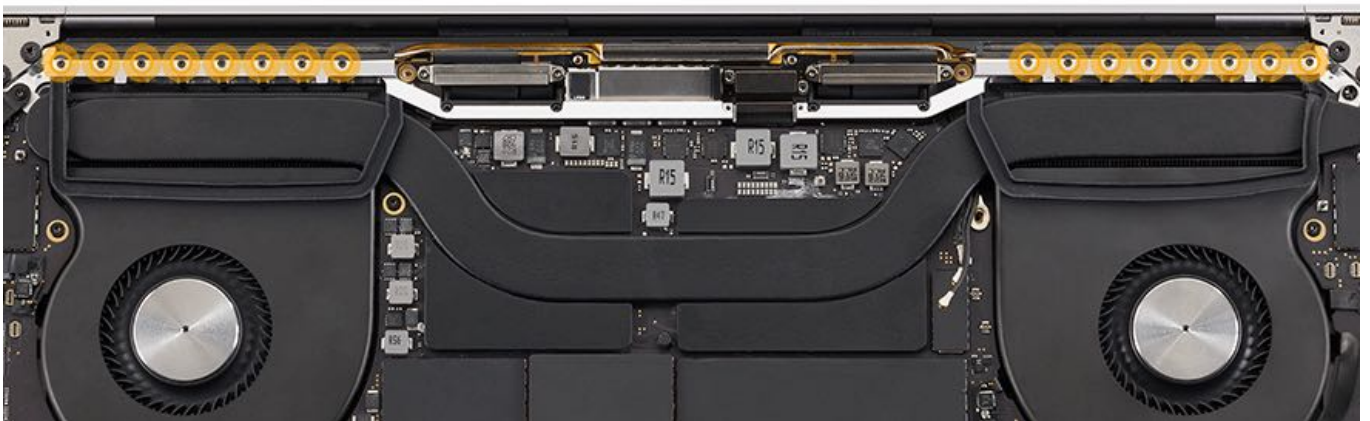




4. Reinstall the 16 1IPR vent/antenna screws (923-01512) with the torque screwdriver and Torx security bit.

**Note:**

- Magnetize the security bit to more easily pick up and reinstall the very small screws.
- Turn each screw until the torque screwdriver clicks (applies the correct torque). Some screws may seat properly without an audible click. Do not overtighten the screws.



5. Reassemble in reverse order of removal steps.

6. Reinstall the [clutch covers](#).

7. Reinstall the [BMU screw, reconnect the battery, and remove the battery cover](#).

8. Reinstall the [bottom case](#).

9. Follow the instructions in [Trackpad Calibration Check](#) to verify the trackpad performance after every repair.

# Fans

## First Steps



### Warning:

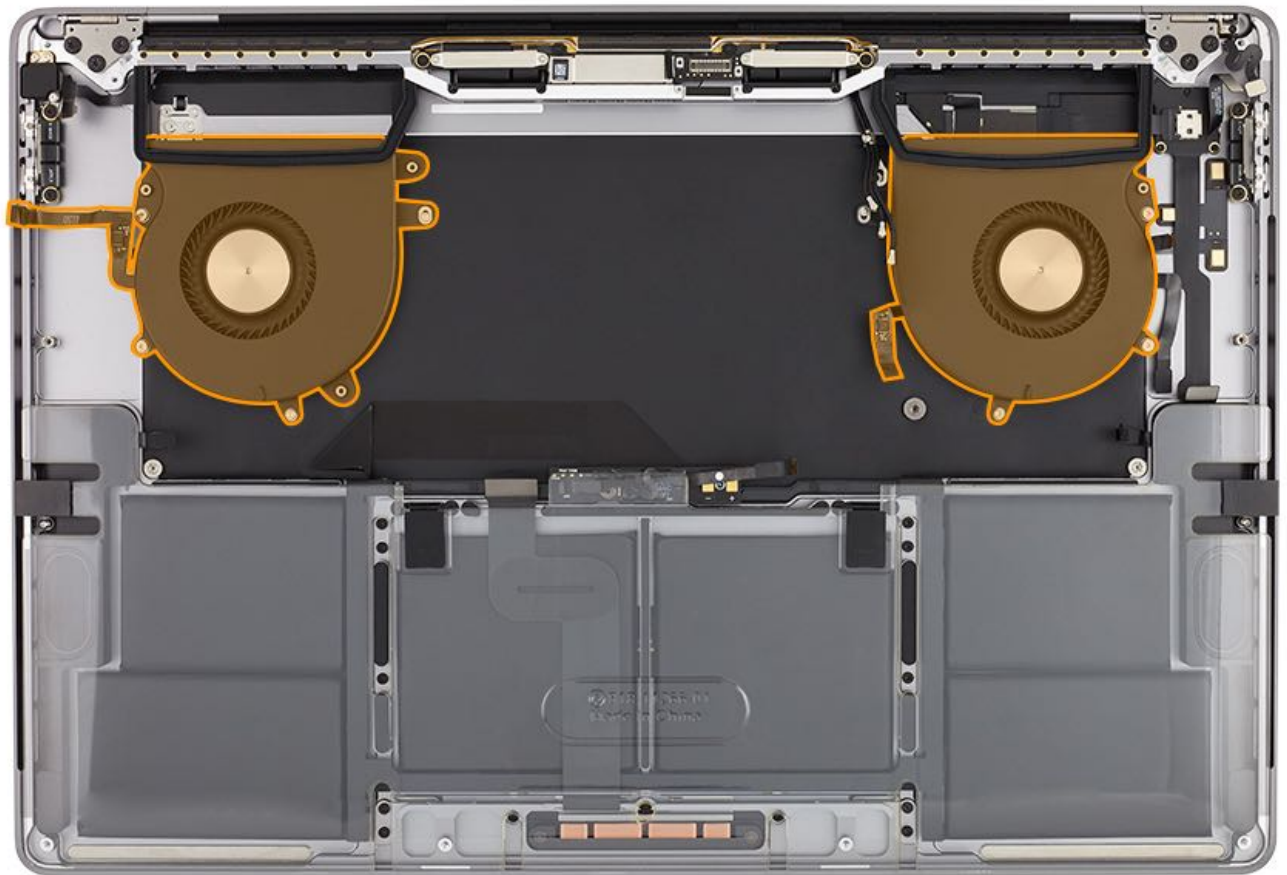
- To avoid damaging parts, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw before you begin a repair.
- Do not apply external power while the computer is under repair.

### Important:

- Only Apple-certified technicians should perform this procedure. Wear an ESD wrist strap and take precautions to avoid ESD.
- 

### Remove:

- [Bottom case](#)
- [Attach battery cover and disconnect battery](#)
- [Clutch covers](#)
- [Logic board](#)



**Note:** The left and right fans can be replaced separately. They do not have to be replaced as a pair. The procedure is the same for both.

## Tools

- Torx T3 screwdriver (magnetized)
- Black stick

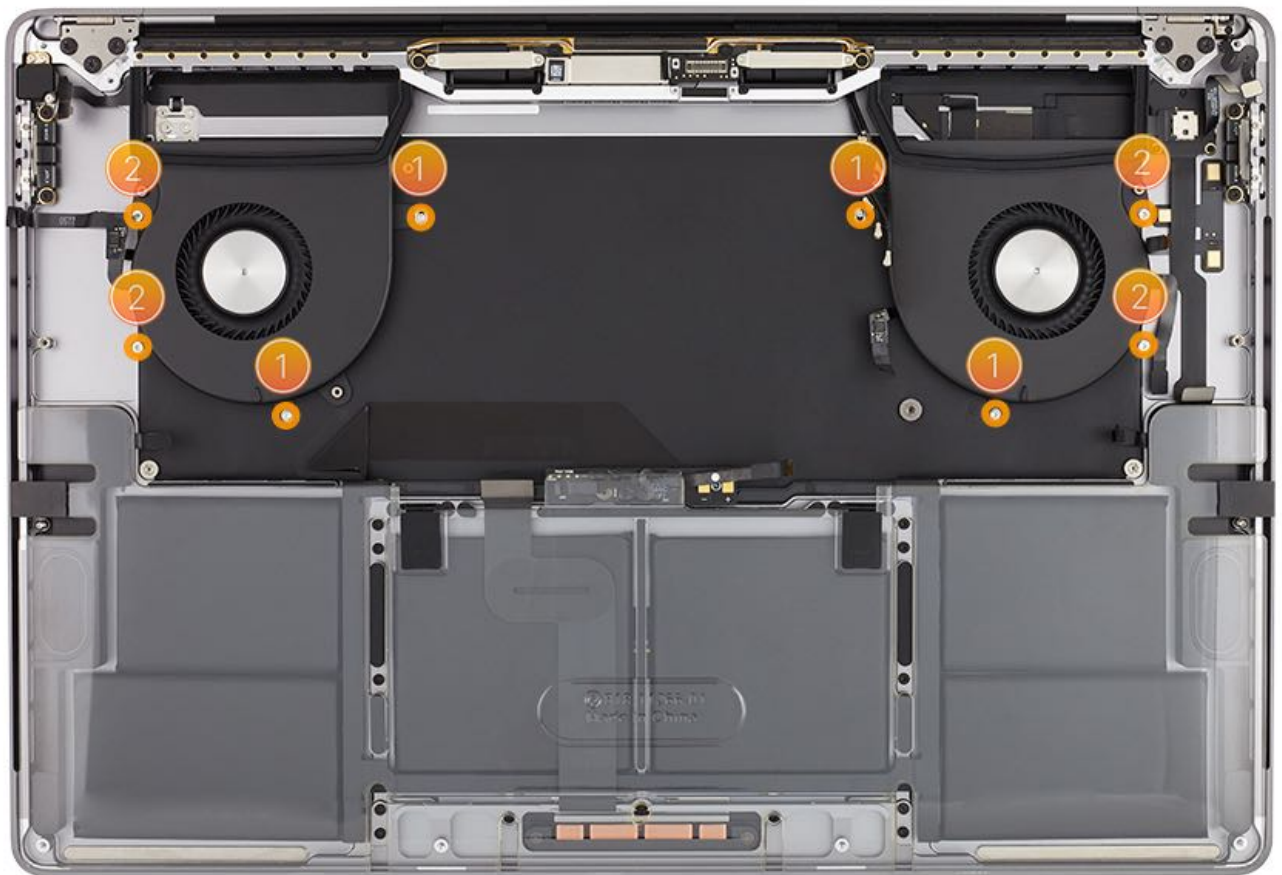




## Steps For Removal

1. If removing one fan, remove two T5 fan screws (1) and two T3 screw (2). If removing both fans, remove four black T3 fan screws (1) and four silver T3 screws (2).

- T5: 923-03967 (position 1)
- T3: 923-03966 (position 2)



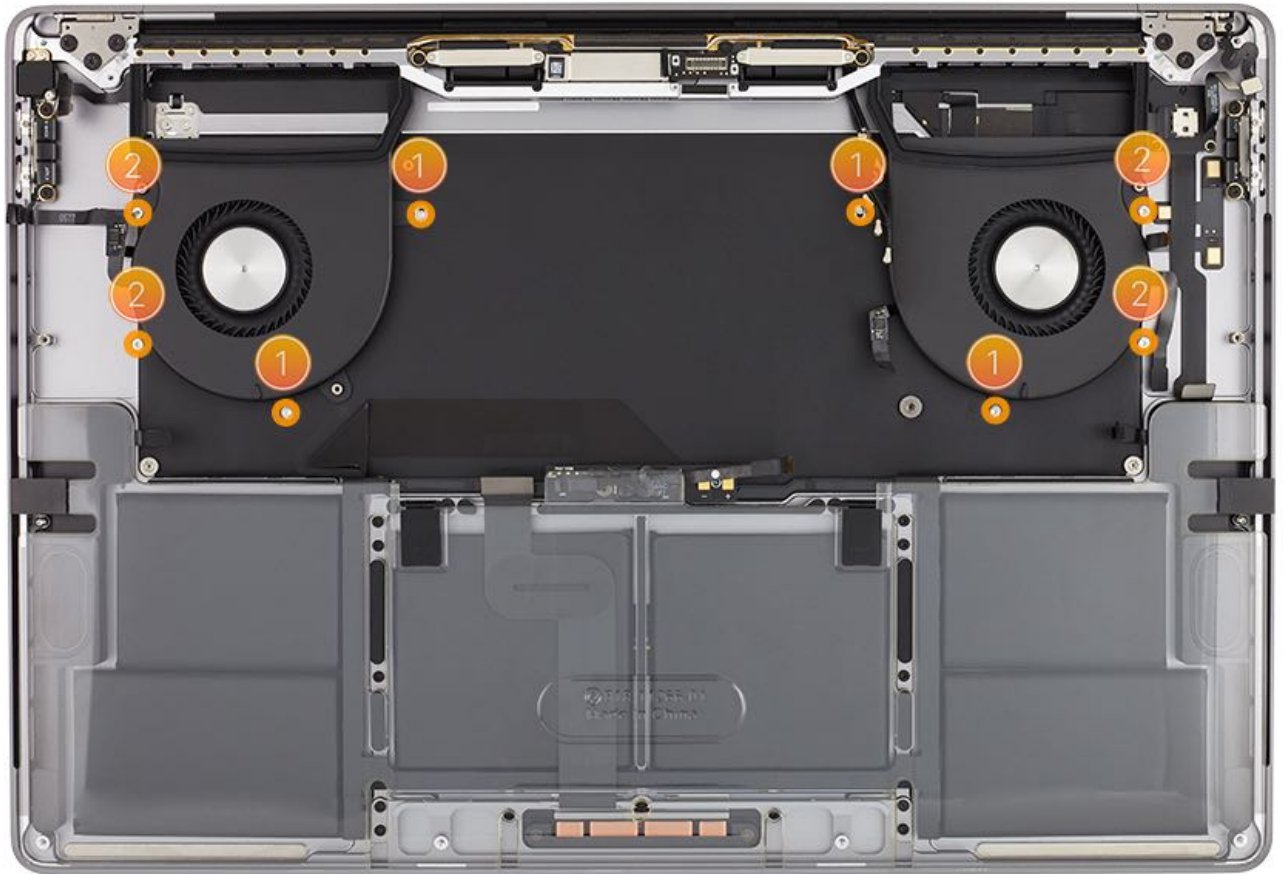
2. Remove fan from top case.

## Steps For Reassembly

1. Place the fan in the top case. Carefully align the screw holes and the screw bosses.

**Note:** It may help to torque screws halfway first to make sure all screws are aligned correctly, and then go back and tighten screws.

- T5: 923-03967 (position 1)
- T3: 923-03966 (position 2)



3. Reinstall the [logic board](#).
4. Reinstall the [clutch covers](#).
5. Reinstall the [BMU screw, reconnect the battery, and remove the battery cover](#).
6. Reinstall the [bottom case](#).
7. Follow the instructions in [Trackpad Calibration Check](#) to verify the trackpad performance after every repair.

# Touch ID Board

## First Steps



### Warning:

- To avoid damaging parts, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw before you begin a repair.
- Do not apply external power while the computer is under repair.

### Important:

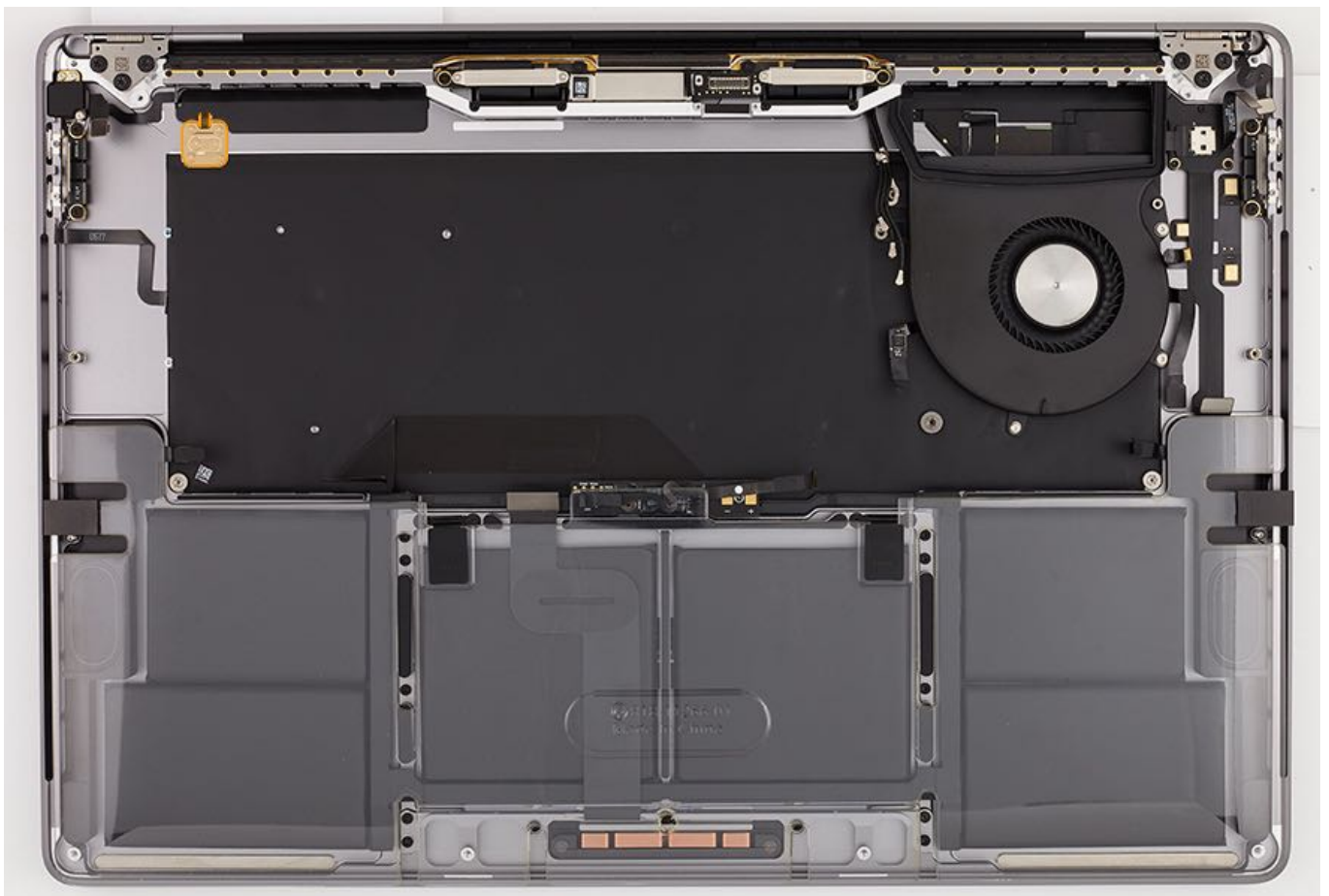
- Only Apple-certified technicians should perform this procedure. Wear an ESD wrist strap and take precautions to avoid ESD.
- 

### Caution:

- This repair is not complete until System Configuration has been performed.

### Remove:

- [Bottom case](#)
- [Attach battery cover and disconnect battery](#)
- [Clutch covers](#)
- [Logic board](#)
- [Right fan](#)



## Tools

- Touch ID alignment tool (923-03032)
- Torx T3 screwdriver
- ESD-safe tweezers
- Black stick
- Kapton Tape



## Steps For Removal

**Important:** The Touch ID board is paired with the logic board. The Touch ID board (661-14481) can be replaced on its own. The logic board does not also have to be replaced.

1. Remove the two T3 screws from the center of the flexure.

- T3: 923-03911

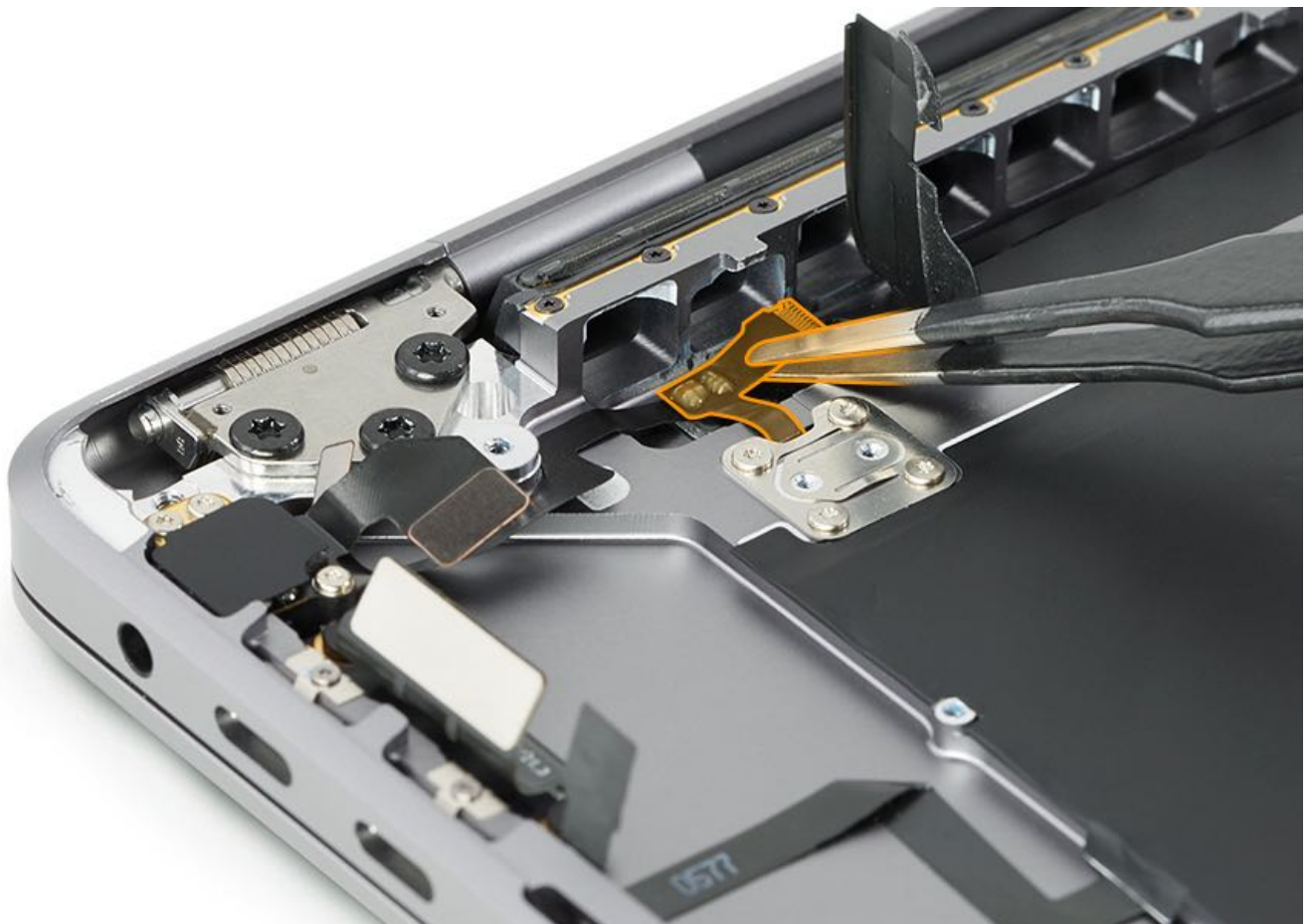


2. Use a black stick to peel the Mylar cover off the Touch ID board flex cable.





3. Flip up the locking lever and use tweezers to disconnect the flex connector.



4. Use the flat end of a black stick to peel up the flex cable from the top case.



5. Remove the four T3 screws from the corners of the flexure.

- T3: 923-03910





6. Use tweezers to remove the flexure from the top case.

7. Open the display and stand the computer assembly on its side. With a hand on each side of the top case, support the Touch ID board as you thread the flex cable through the slot. Remove the Touch ID board from the keyboard side of the top case.





## Steps For Reassembly

1. Place the computer upright with the display fully open. Set two Y-shaped alignment tools in the top case opening and situate the tabs in the corner edge. Secure the tools with Kapton tape.



2. With the computer on its side, support the Touch ID board as you thread the flex cable through the slot in the top case. Press the Touch ID button into the square opening. **Note:** When installing a replacement Touch ID board, remove the protective film from the glass surface.

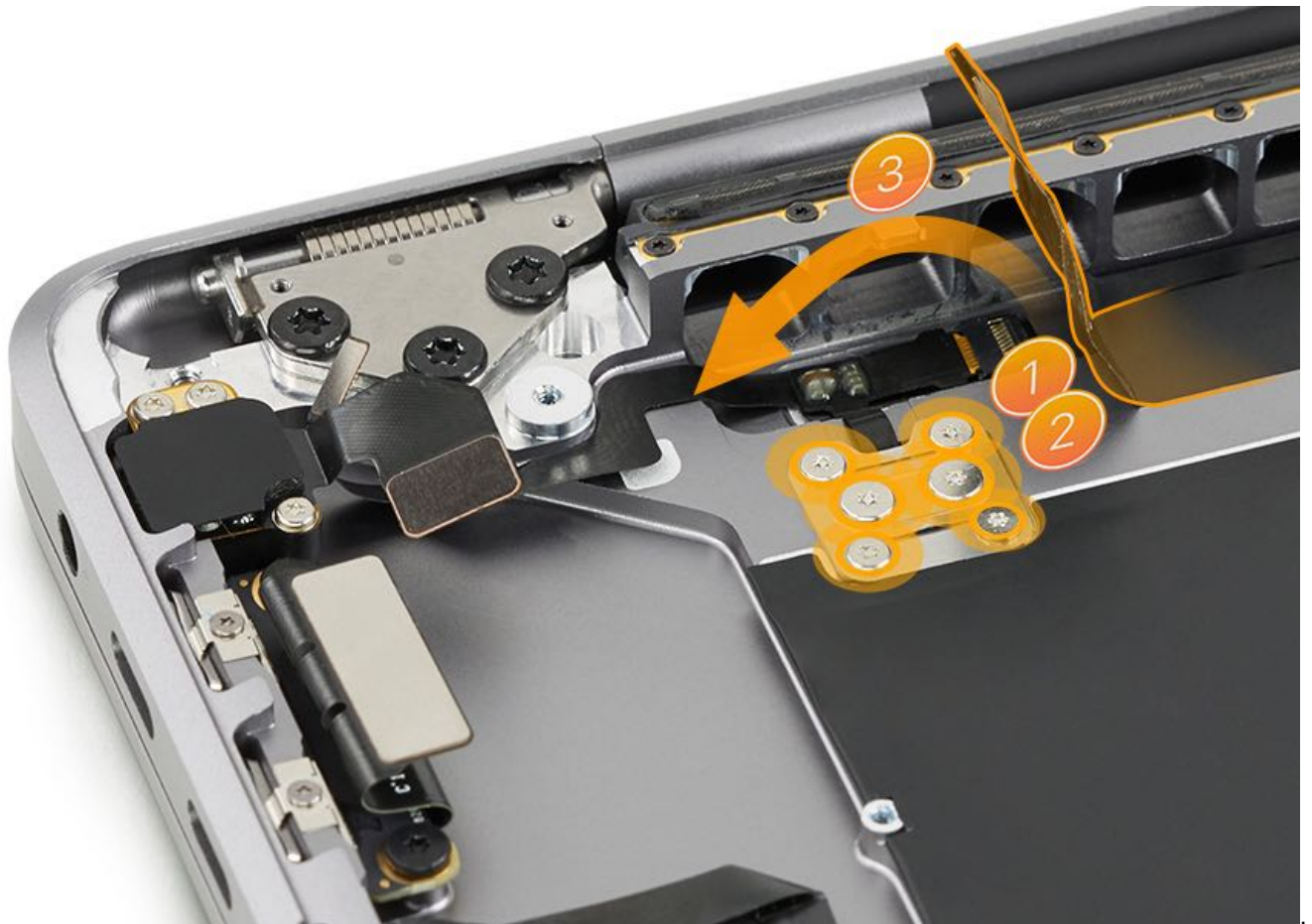




3. Hold the Touch ID button in place, carefully close the display and set the computer display side down flat on the mat.
4. Using tweezers, reinstall the flexure so that the keyed side fits the Touch ID cable. Be sure it is installed right side up or the button may not function properly.



5. Loosely install all six flexure screws (1 and 2), starting with the four outside screws first. Then reconnect the flex cable and attach the Mylar (3).



6. Starting from the corner screws, tighten all six screws.
7. Place the computer flat on the ESD mat, be careful not to bend the any flex cables. **Warning:** Be sure the battery cover is attached.
8. Remove the tape and alignment tools and look at the Touch ID button to verify that all the sides are spaced equally. If not, loosen the screws and start the alignment process again.
9. Press the Touch ID button to verify that it makes a clicking noise. If the button does not move at all or moves but does not click, refer to [Touch ID Shim](#) for details.
10. Reinstall the [right fan](#).
11. Reinstall the [logic board](#).
12. Reinstall the [clutch covers](#).
13. Reinstall the [BMU screw, reconnect the battery flex cable, and remove the battery cover](#).
14. Reinstall the [bottom case](#).



15. **Caution:**

- This repair is not complete until System Configuration has been performed.

16. Follow the instructions in [Trackpad Calibration Check](#) to verify the trackpad performance after every repair.

# Touch ID Shim

## First Steps

This article describes the process to replace the Touch ID Shim after the Touch ID board has been replaced. For instructions on replacing the Touch ID board, refer to the Table of Contents for the model you are repairing.



### Warning:

- To avoid damaging parts, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw before you begin a repair.
- Do not apply external power while the computer is under repair.

### Important:

- Only Apple-certified technicians should perform this procedure. Wear an ESD wrist strap and take precautions to avoid ESD.
- For MacBook Pro (15-inch, 2016 and 2017) only: The logic board is paired with the Touch ID board. When replacing one, you must replace the other.
- For MacBook Pro (15-inch, 2018 and 2019) and MacBook Pro (16-inch, 2019): The Touch ID board can be replaced without replacing the logic board. However, if the logic board is replaced the Touch ID board must also be replaced.



## Tools

- Torx T3 screwdriver (magnetized)
- ESD-safe round-nose tweezers
- Shim kit, package of 3 (923-01519), not shown





## Steps For Removal

**Note:** The Touch ID shim is a tiny, circular part. Make sure your work surface is completely clean. A clean surface allows easy location of the shim if it lands on the ESD mat during this repair.

1. Press the Touch ID button a few times to check its response:

- If the button feels too loose or does not click, a larger Touch ID shim is required.
- If the button feels too stiff or does not move, a smaller Touch ID shim is required.



2. Spread the tips of the round-nose tweezers, and use one tip to push the Touch ID shim out.





3. Retrieve the loose shim on the keyboard side of the top case. The Touch ID shim has a small bit of adhesive and may stick to the top case. The adhesive side of the shim is black and the opposite side is silver.





### Steps For Reassembly

1. Replace the Touch ID shim with one of the supplied shims from the kit (923-01519), which are marked and organized by size.

- Use tweezers to remove the appropriate shim from the backing.
- Keep less than half of the shim on the tweezer head for easier installation.

2. Set the computer flat on the ESD mat.

**Important:** Be sure the battery cover is in position and the left and right I/O boards are flat.



3. Align the shim in the recessed circle on the top case.



4. Gently press the shim to activate the adhesive.



5. Return to the Touch ID board article to complete the repair.

- For MacBook Pro (16-inch, 2019): [Touch ID board](#)



# Input/Output (I/O) Boards

## First Steps



### Warning:

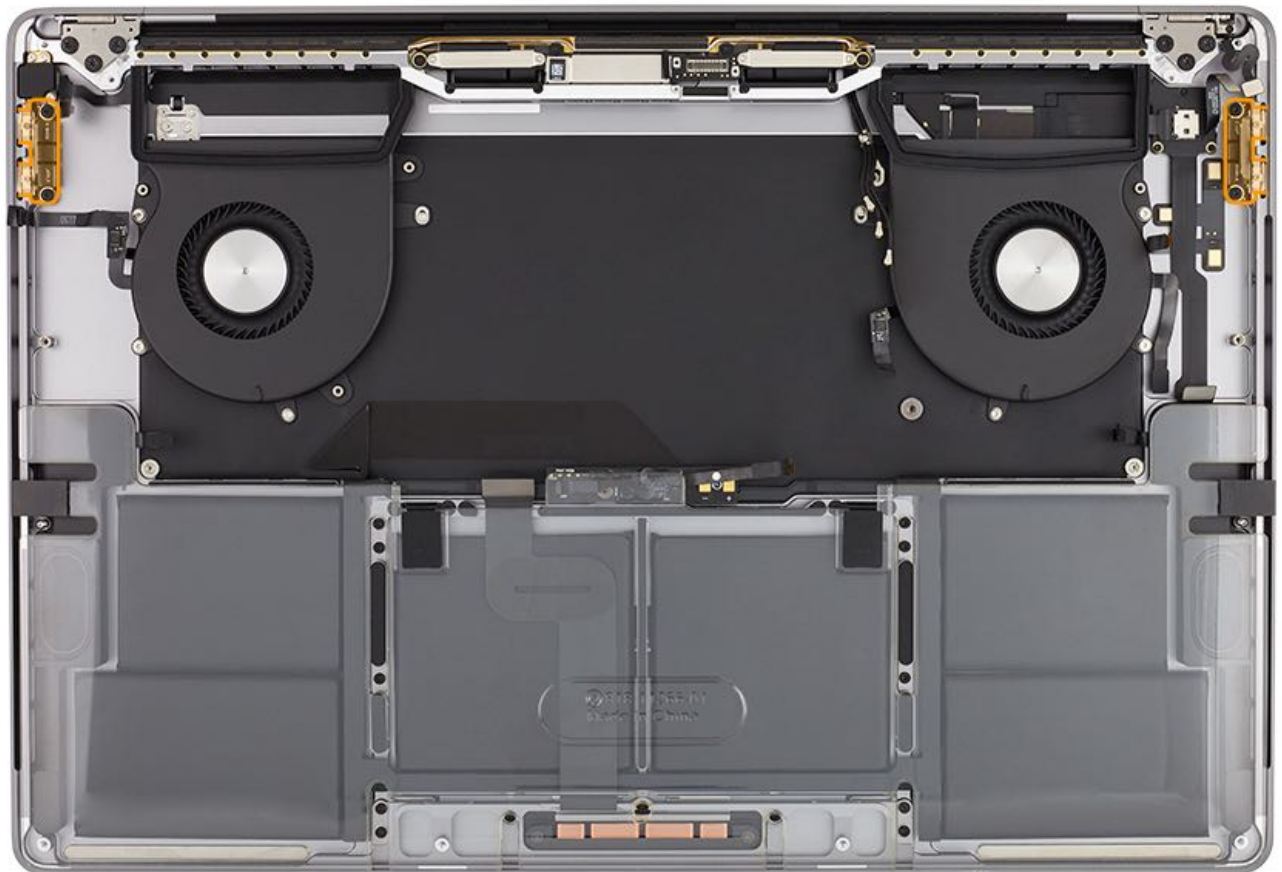
- To avoid damaging parts, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw before you begin a repair.
- Do not apply external power while the computer is under repair.

### Important:

- Only Apple-certified technicians should perform this procedure. Wear an ESD wrist strap and take precautions to avoid ESD.
- 

### Remove:

- [Bottom case](#)
- [Attach battery cover and disconnect battery](#)
- [Clutch covers](#)
- [Logic board](#)



## Tools

- Torx T5 screwdriver (magnetized)
- Black stick

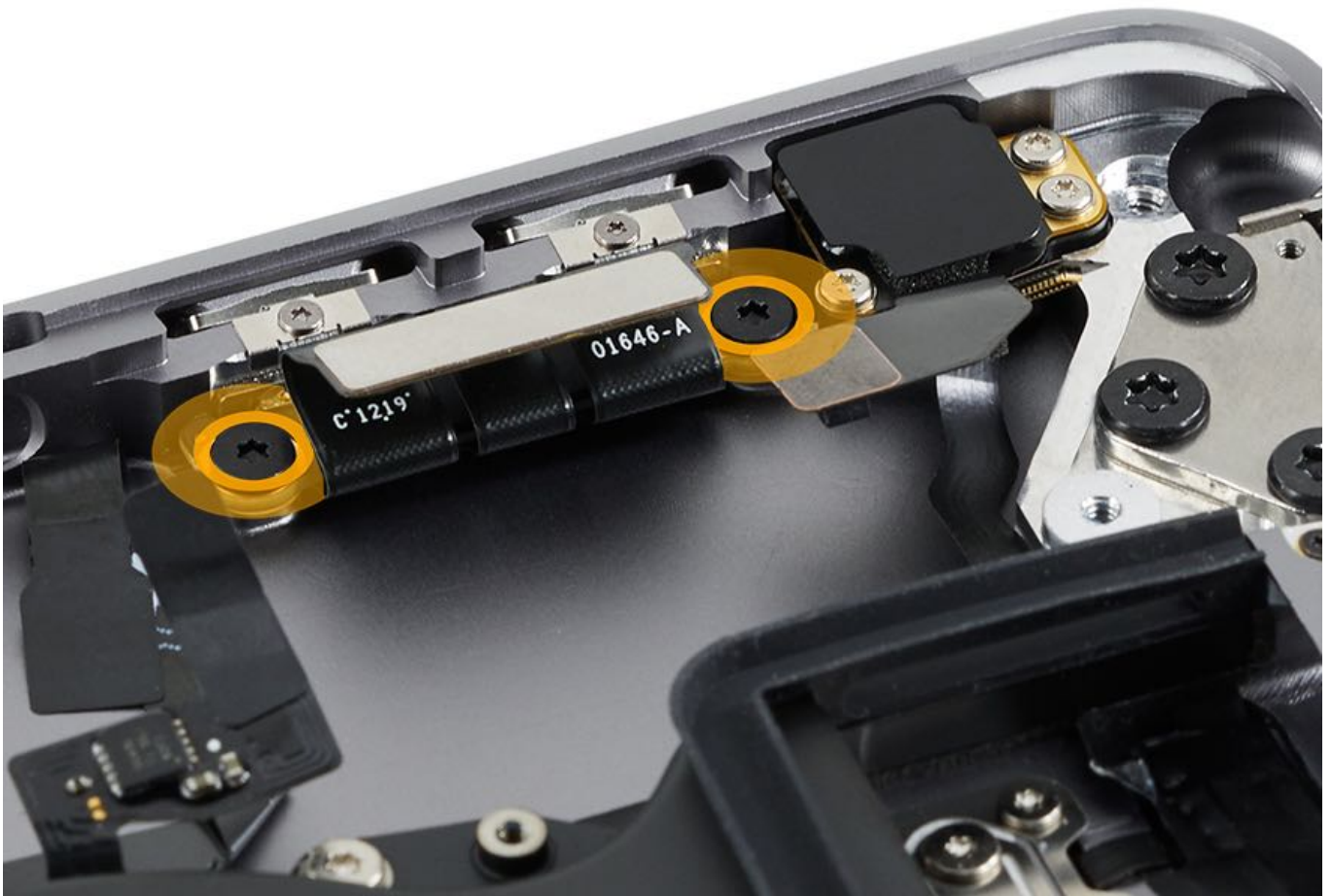




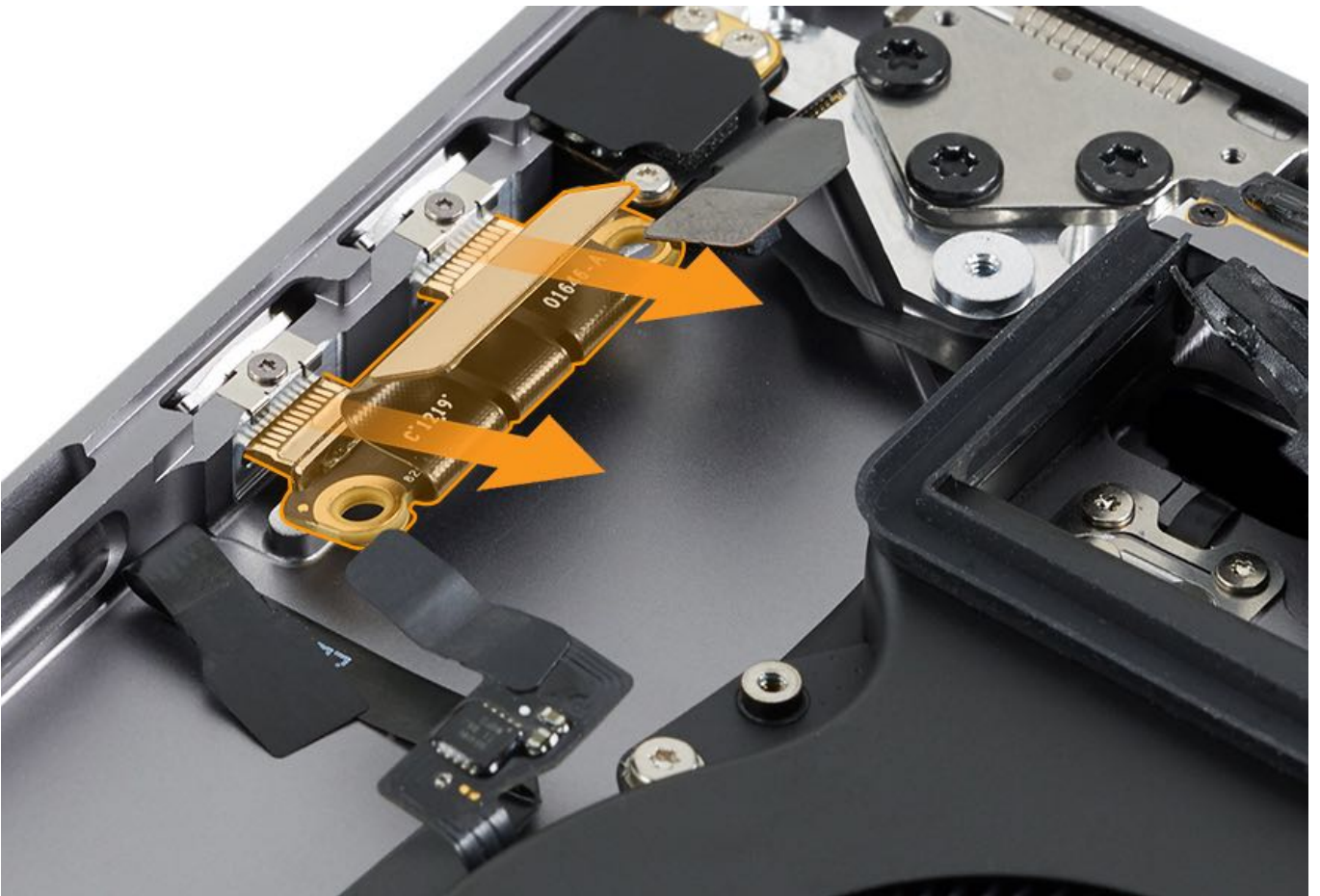
## Steps For Removal

1. Remove two T5 screws from the I/O board.

- T5: 923-03967

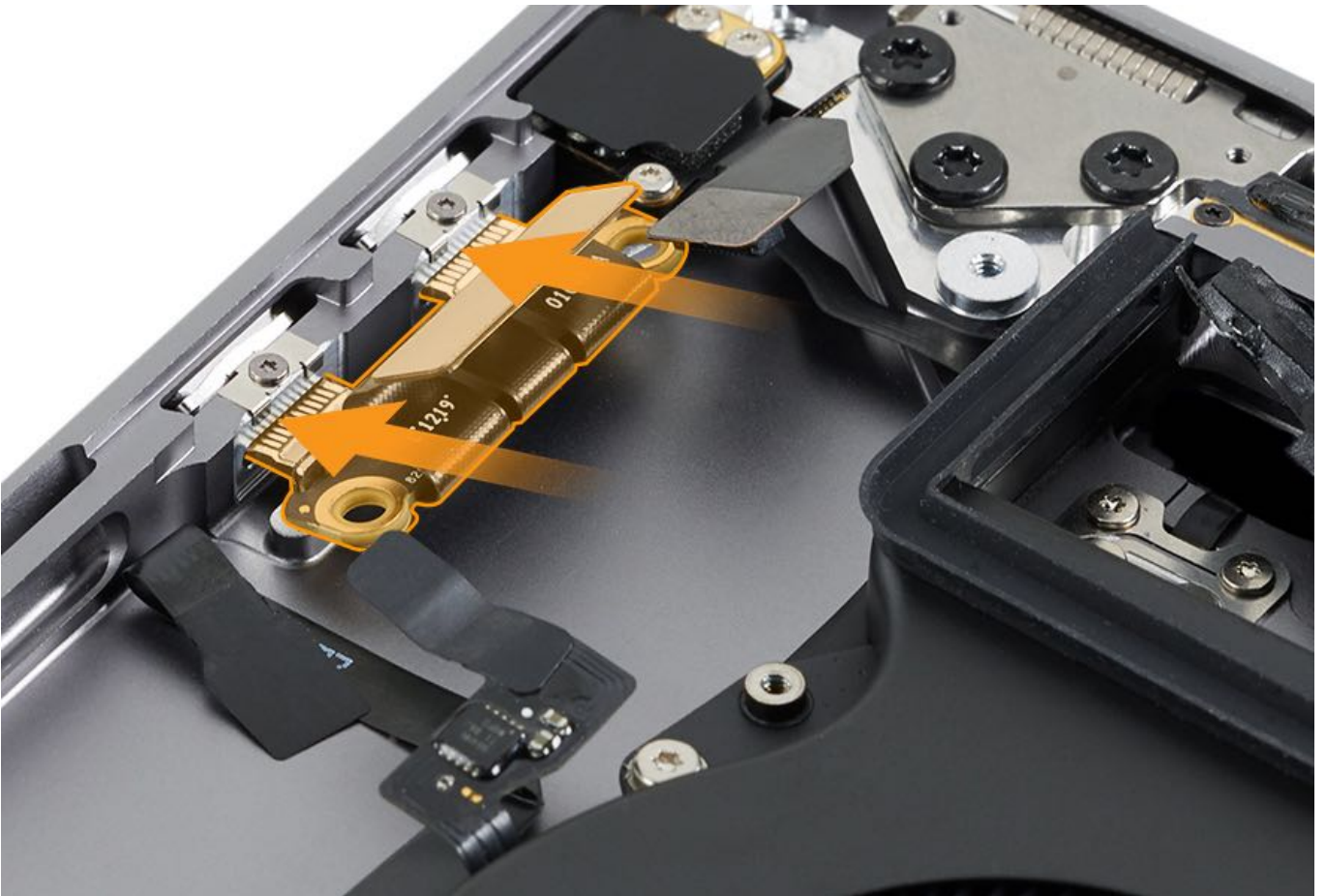


2. Grasp the board by the sides and gently slide it out of the ports.

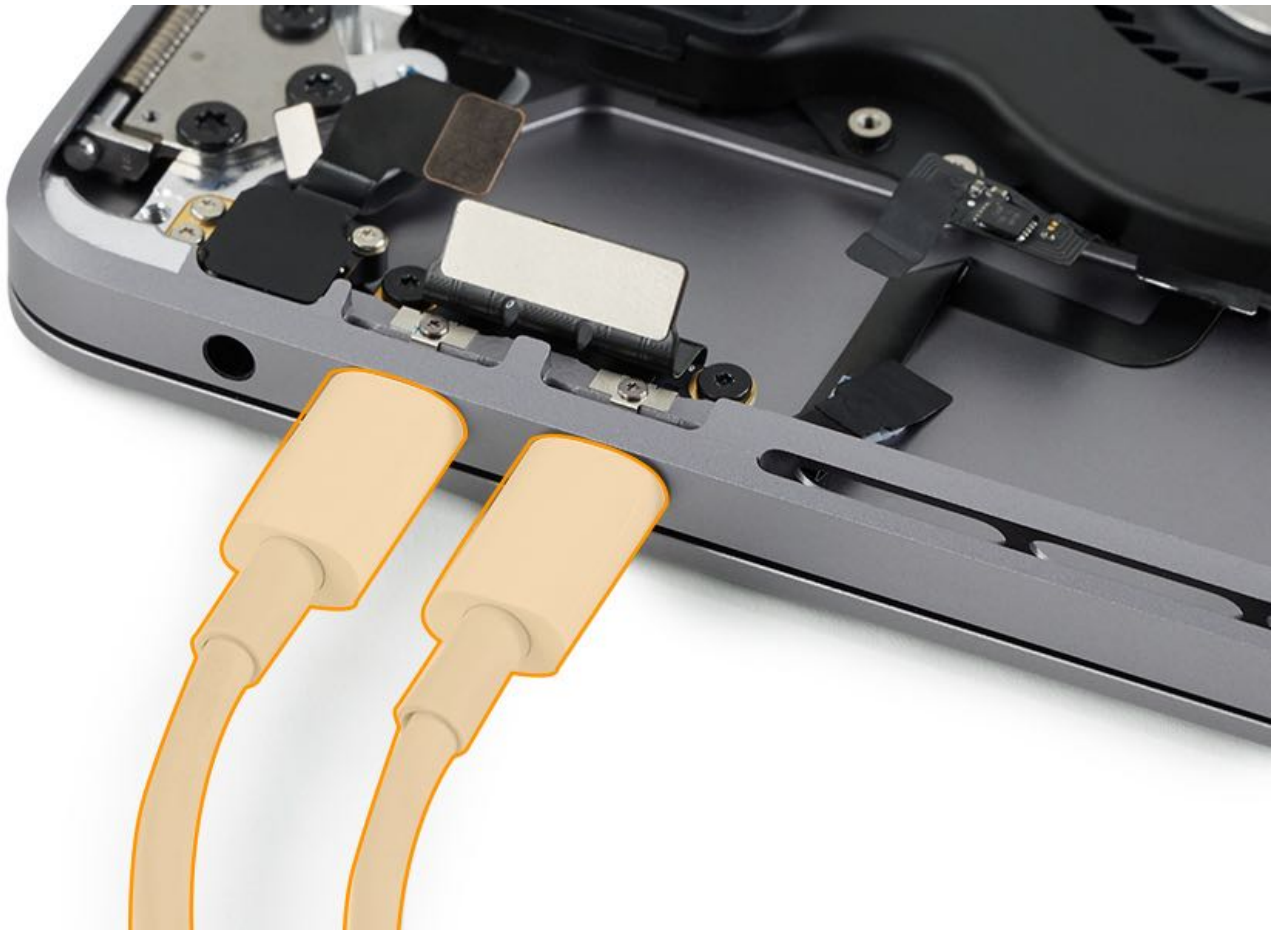


## Steps For Reassembly

1. Reinstall the I/O board into the top case.



2. After placing the board into position in the top case, plug an external USB-C charging cable into both Thunderbolt 3 ports.  
**Warning:** The charging cable should **not** be plugged into power.



3. Keeping the cable connected, check that the screw holes in the board align with the screw bosses in the top case. Then reinstall the two T5 (923-03967) screws.
4. Reinstall the [logic board](#).
5. Reinstall the [clutch covers](#).
6. Reinstall the [BMU screw, reconnect the battery, and remove the battery cover](#).
7. Reinstall the [bottom case](#).
8. Follow the instructions in [Trackpad Calibration Check](#) to verify the trackpad performance after every repair.



# Display Assembly

## First Steps



### Warning:

- To avoid damaging parts, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw before you begin a repair.
- Do not apply external power while the computer is under repair.

### Important:

- Only Apple-certified technicians should perform this procedure. Wear an ESD wrist strap and take precautions to avoid ESD.
- 

### Caution:

- This repair is not complete until System Configuration has been performed. After placing the computer into DFU mode, the display must be closed for System Configuration to perform correctly.
- If the display is replaced, the Lid Angle Sensor (LAS) module must also be replaced.
- 

### Remove:

- [Bottom case](#)
- [Attach battery cover and disconnect battery](#)
- [Clutch covers](#)
- [Vent/antenna module](#)





## Tools

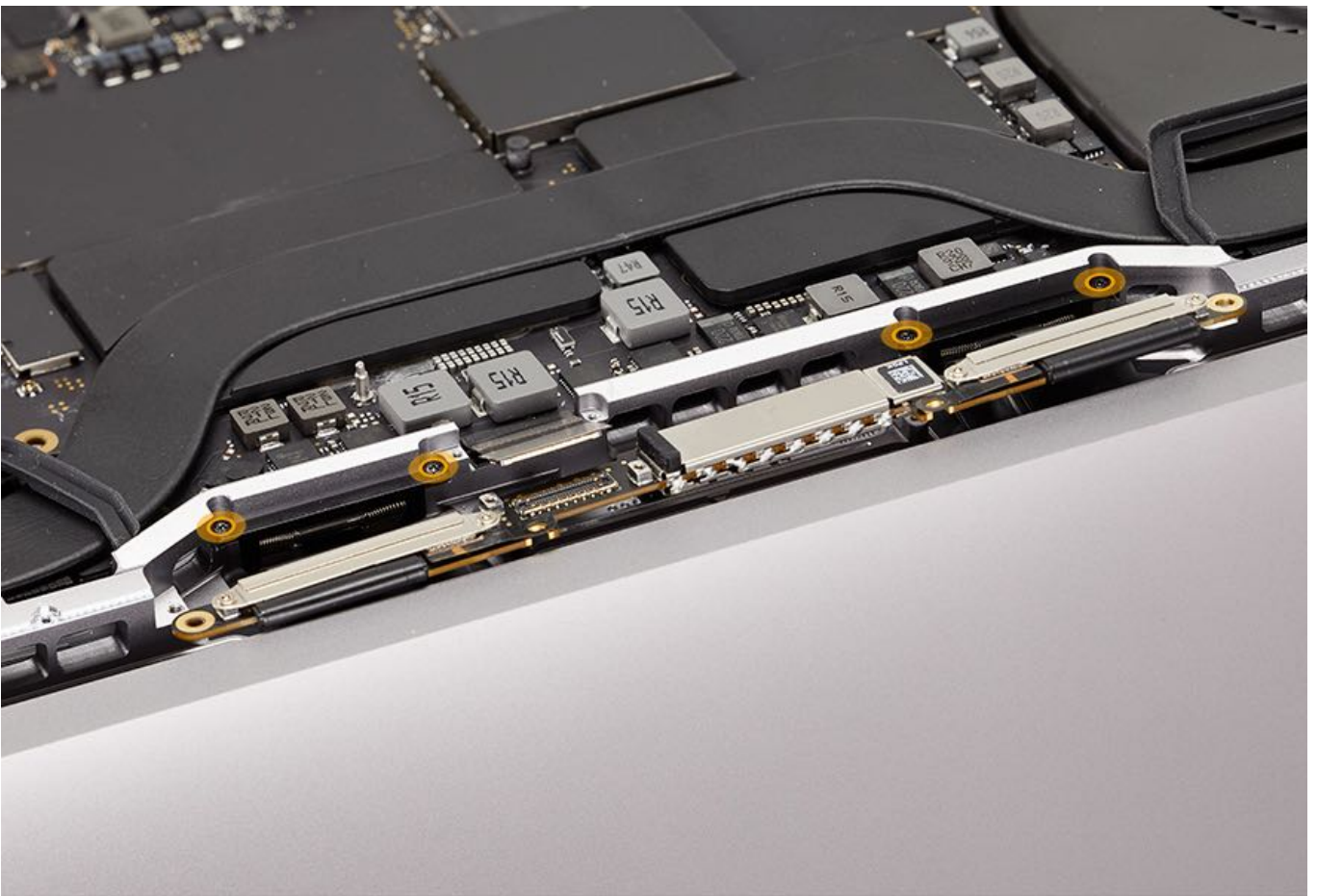
- Torx T3 screwdriver
- Torx T8 screwdriver



## Steps For Removal

1. Remove four T3 spring tensioner screws secured to the rear wall.

- T3: 923-01185



2. Open the display and place the computer on the edge of a workbench, with the display hanging down.



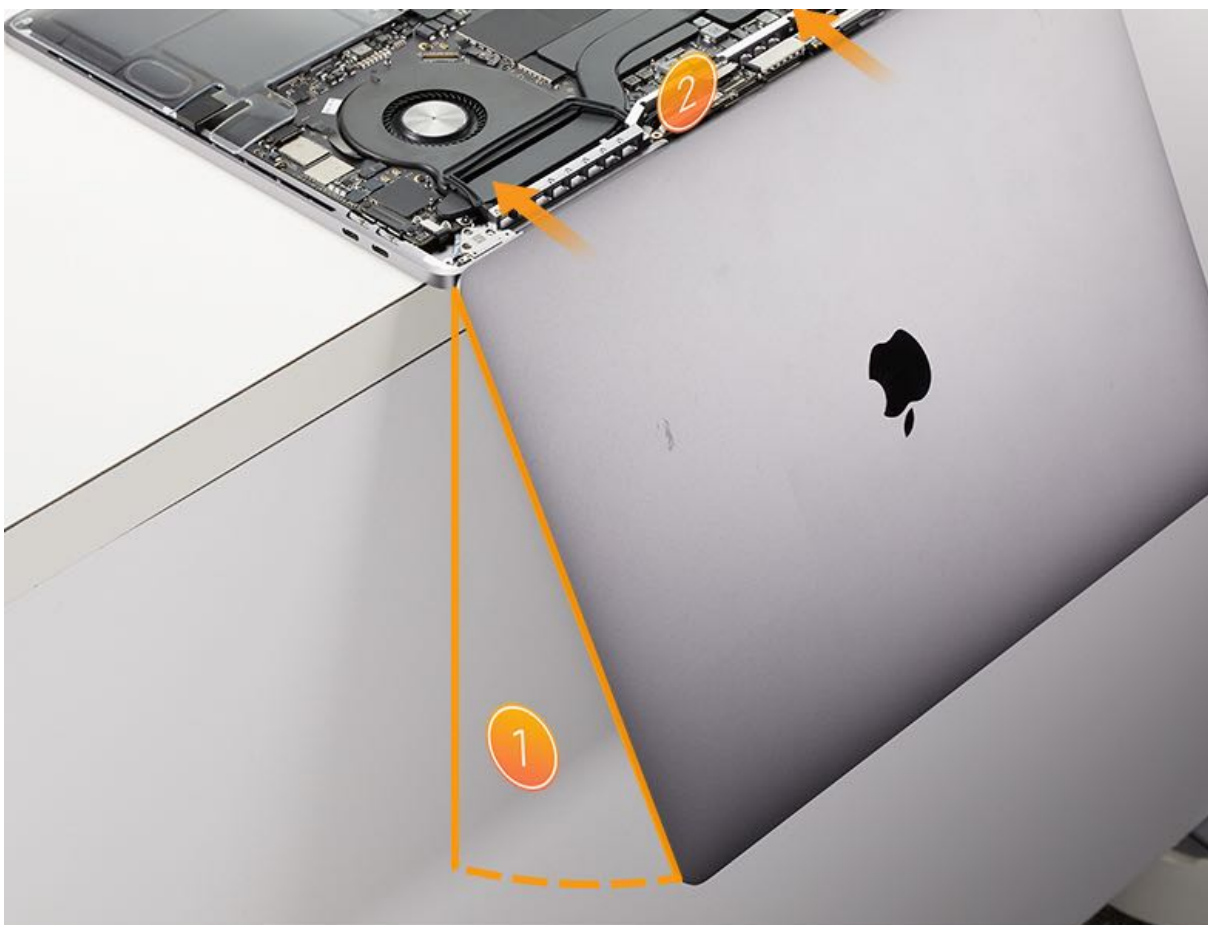
3. Remove six T8 display hinge screws.

- T8: 923-01173





4. Separate the display assembly from the top case. Pull the display toward you about 15 degrees (1), then lift the display up and off the top case (2).



### Steps For Reassembly

**Caution:** If reinstalling the display assembly, inspect the left hinge and ensure the magnet is still in place. If the magnet is



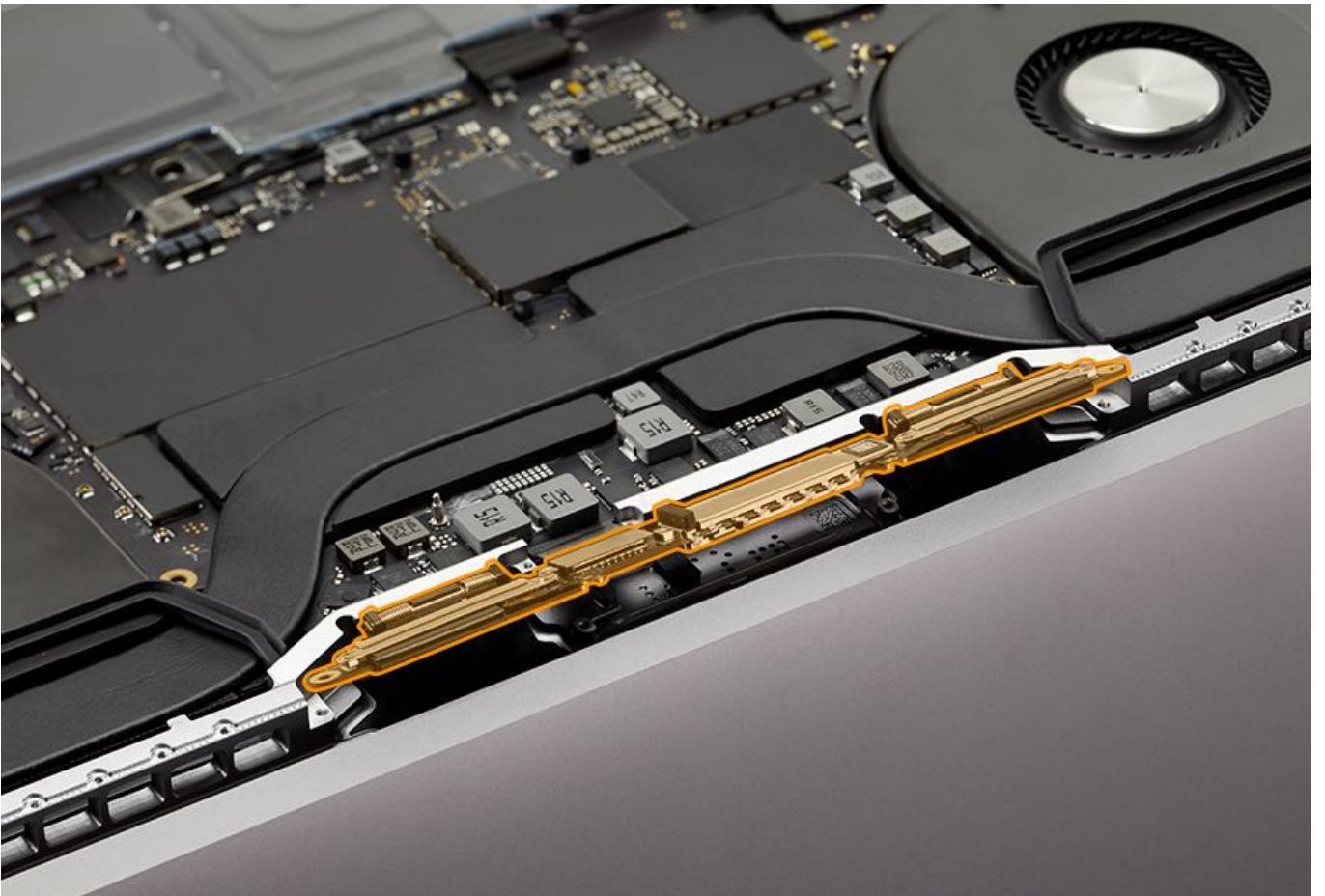
missing, the display assembly must be replaced.



**Caution:** The display assembly includes the TCON board and the spring tensioners. Be careful not to damage these components when reinstalling the display assembly.

1. Reinstall the display onto the top case. Make sure that the TCON board and spring tensioners are positioned within the top case. If reassembled incorrectly, the TCON board and spring tensioners could get wedged between the top case and the display.





2. Loosely reinstall the six T8 display hinge screws (923-01173) in the order shown.



3. Close the computer, and adjust the display alignment to the top case by touch.

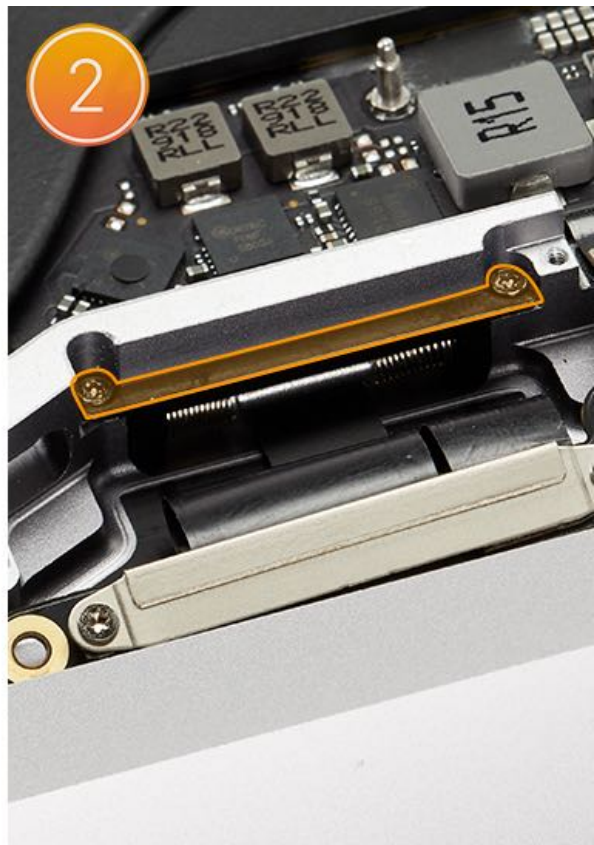


4. Stand up the computer on a clean, flat surface to level the front-to-rear clutch alignment.



5. Tighten all six T8 screws.

6. Roll the spring tensioners forward and align the screw holes on the spring tensioners with the screw holes on the rear wall. Reinstall the T3 screws (923-01185).



7. Reinstall the [vent/antenna module](#).

8. Reinstall the [clutch covers](#).

9. Reinstall the [BMU screw, reconnect the battery, and remove the battery cover](#).

10. Reinstall the [bottom case](#).



**11. Caution:**

- If the display has been replaced, a new LAS must be installed.
- This repair is not complete until the System Configuration has been performed.  
After placing the computer into DFU mode, the display must be closed for System Configuration to perform correctly.
- 

12. Follow the instructions in [Trackpad Calibration Check](#) to verify the trackpad performance after every repair.



# Lid Angle Sensor (LAS) Module

## First Steps



### Warning:

- To avoid damaging parts, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw before you begin a repair.
- Do not apply external power while the computer is under repair.

### Important:

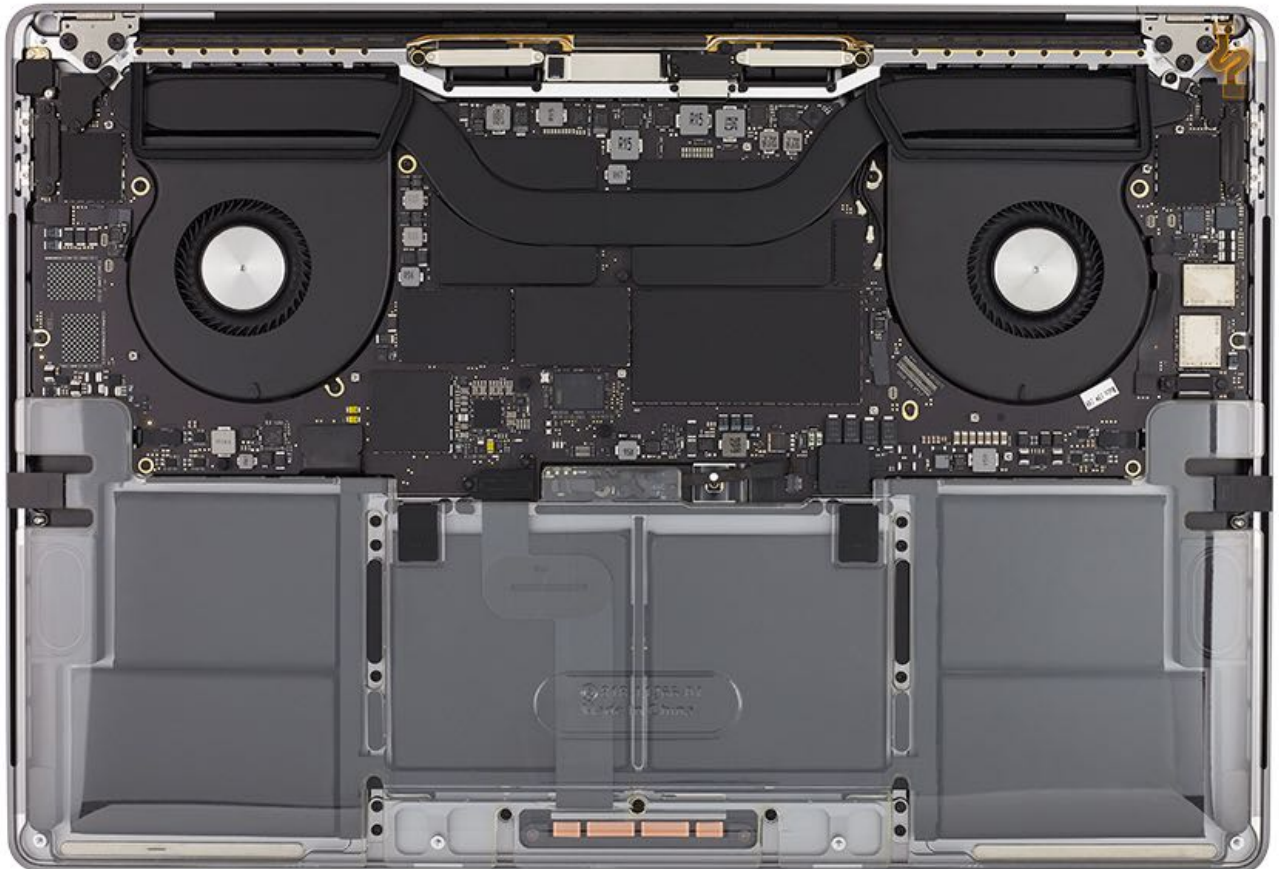
- Only Apple-certified technicians should perform this procedure. Wear an ESD wrist strap and take precautions to avoid ESD.

### Caution:

- If the display assembly is replaced, the Lid Angle Sensor (LAS) module must also be replaced. However, a new LAS can be installed without installing a new display assembly.
- This repair is not complete until System Configuration has been performed. After placing the computer into DFU mode, the display must be closed for System Configuration to perform correctly.
- This repair is not complete until the Lid Angle Sensor diagnostic suite is performed in AST 2.

### Remove:

- [Bottom case](#)
- [Attach battery cover and disconnect battery](#)
- [Clutch covers](#)





## Tools

- Torx T3 screwdriver
- Torque screwdriver (blue), 0.65kgf-cm (923-0448)
- Torx security bit (923-0247)



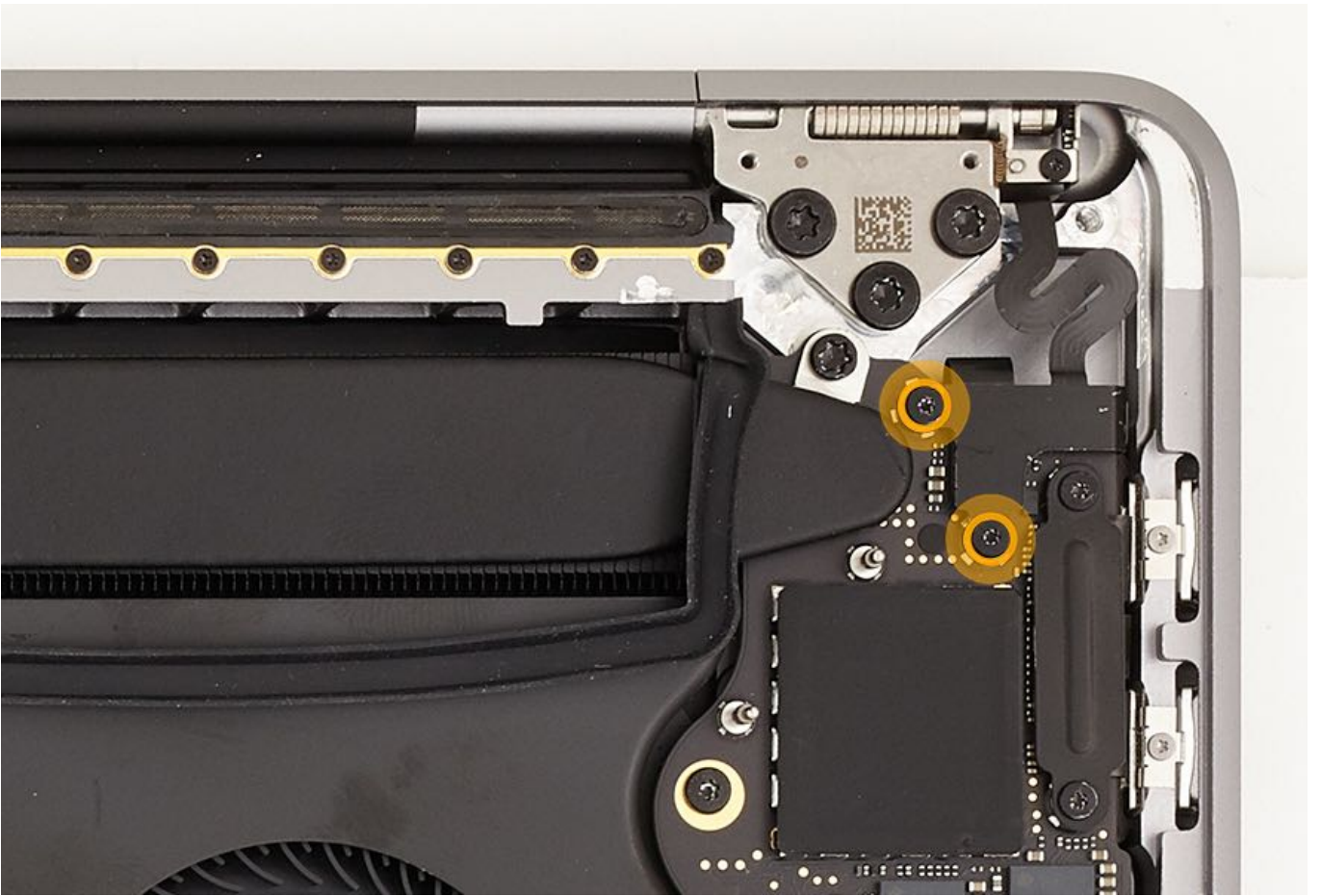
## Steps For Removal



**Caution:** Before proceeding with this repair, examine the magnet on the left clutch of the display assembly. If the magnet is missing, a new display assembly is required.



1. Remove two T3 screws (923-03969) from the cowling. Remove the cowling and save for reuse.



2. Disconnect the flex cable.



3. Remove the 1IPR screw (923-03909) from the flex cable.





4. Remove the LAS from the top case.

### **Steps For Reassembly**

1. Connect the flex connector to the logic board.





2. Position the metal clip so the hole is aligned with the screw hole. Reinstall the 1IPR (923-03909) screw to secure the LAS.
3. Reinstall the cowling and the T3 cowling screws (923-03969).



**4. Caution:**

- This repair is not complete until the System Configuration has been performed. F  
After placing the computer into DFU mode, the display must be closed for System Configuration to perform correctly.
- 

5. To ensure the LAS functions properly, the Lid Angle Sensor suite in AST 2 must be performed.
6. Follow the instructions in [Trackpad Calibration Check](#) to verify the trackpad performance after every repair.

# Top Case with Battery

## First Steps



### Warning:

- To avoid damaging parts, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw before you begin a repair.
- Do not apply external power while the computer is under repair.

### Important:

- Only Apple-certified technicians should perform this procedure. Wear an ESD wrist strap and take precautions to avoid ESD.
- Regional top cases have the same base part number, but they include a language code prefix (for example, Italian = T661-13161). Confirm the correct keyboard language before replacing the top case.

### Caution:

- This repair is not complete until System Configuration has been performed.

### Remove:

- [Bottom case](#)
- [Attach battery cover and disconnect battery](#)
- [Clutch covers](#)
- [Audio board](#)
- [Logic board](#)
- [Vent/antenna module](#)
- [Display assembly](#)
- [Lid Angle Sensor \(LAS\) module](#)
- [Fans](#)
- [I/O boards](#)
- [Touch ID board](#)

## Tools

No tools are needed.

## Steps For Removal

After all the items listed above are removed, the top case assembly remains.



**Warning:** The battery is part of the top case module. **Do not attempt to remove the battery from the top case.**

These components will also remain in the top case:

- Battery
- Keyboard
- Trackpad
- Microphone
- Trackpad flex cable
- Touch Bar flex cable
- Touch ID board flex cable
- Speakers
- Keyboard flex cable

## Steps For Reassembly

1. Reassemble in the following order:

- [Display assembly](#)
- [Lid Angle Sensor \(LAS\) module](#)
- [Touch ID board](#)
- [I/O boards](#)
- [Fans](#)
- [Vent/antenna module](#)
- [Logic board](#)
- [Audio board](#)
- [Clutch covers](#)
- [Remove battery cover and connect the battery](#)
- [Bottom case](#)



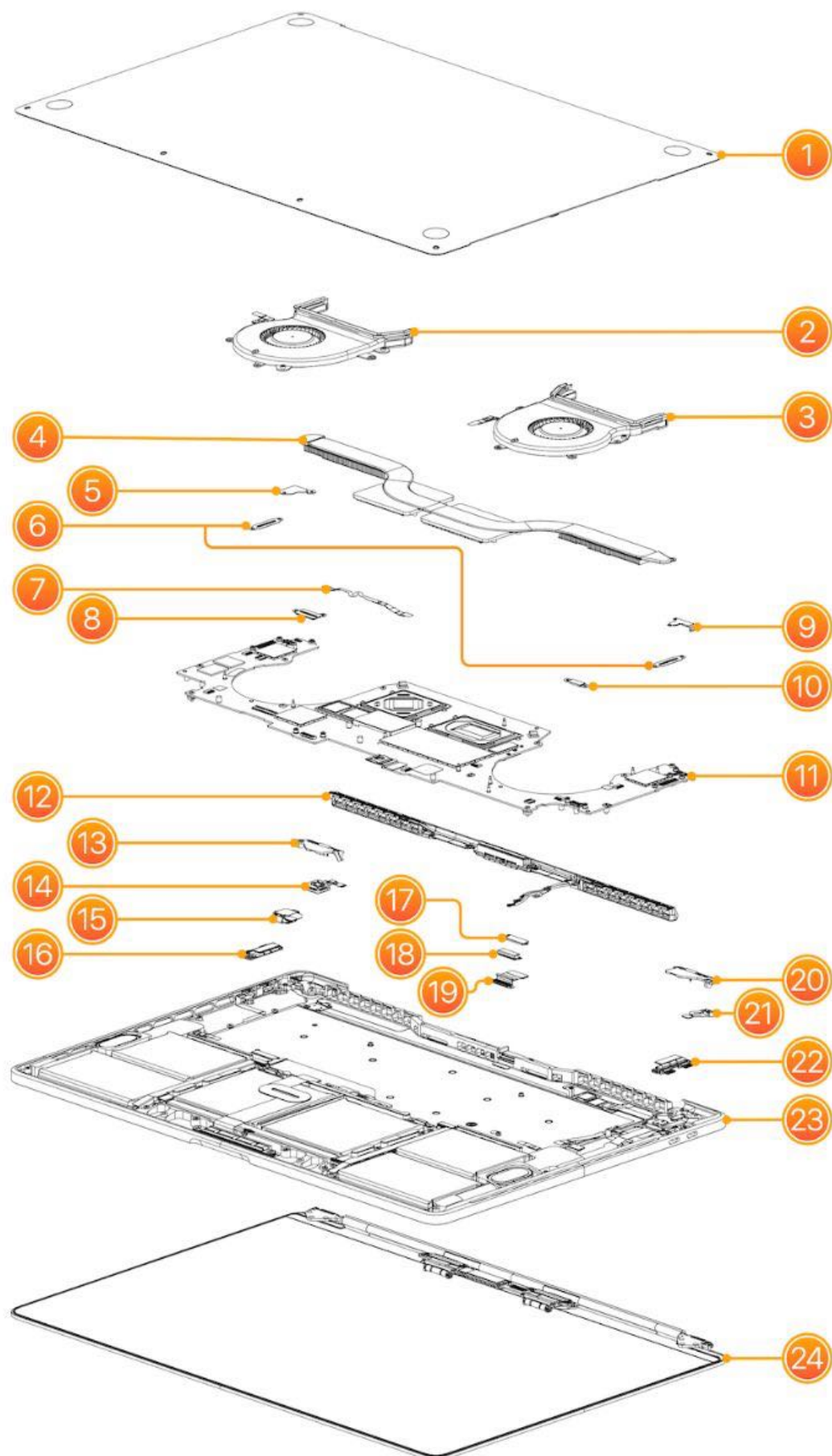
2. **Caution:**

- This repair is not complete until the System Configuration has been performed.

3. Follow the instructions in [Trackpad Calibration Check](#) to verify the trackpad performance after every repair.

# MacBook Pro (16-inch, 2019) Exploded View

Exploded View for MacBook Pro (16-inch, 2019)



1. Bottom Case



- 923-03844, space gray
- 923-03845, silver

## **2. Fan, Right**

- 923-03875

## **3. Fan, Left**

- 923-03874

## **4. Heat Sink**

- 076-00453

## **5. Touch ID/Audio board cowling**

- 923-03941

## **6. I/O Board Cowling**

- 923-03937

## **7. BMU flex cable**

- 923-03932

## **8. Trackpad flex cowling**

- 923-03943

## **9. Touch Bar/Lid Angle Sensor Flex Cowling**

- 923-03938

## **10. Touch Bar Display Cowling**

- 923-03942

## **11. Logic Board**

### **2.6GHz 6-core Intel Core i7**

Radeon Pro 5300M

- 661-14104, Logic Board, 2.6GHz, i7, 16GB, 5300M, 512GB
- 661-14105, Logic Board, 2.6GHz, i7, 16GB, 5300M, 1TB
- 661-14106, Logic Board, 2.6GHz, i7, 16GB, 5300M, 2TB
- 661-14107, Logic Board, 2.6GHz, i7, 16GB, 5300M, 4TB
- 661-14108, Logic Board, 2.6GHz, i7, 16GB, 5300M, 8TB
- 661-14114, Logic Board, 2.6GHz, i7, 32GB, 5300M, 512GB
- 661-14115, Logic Board, 2.6GHz, i7, 32GB, 5300M, 1TB
- 661-14116, Logic Board, 2.6GHz, i7, 32GB, 5300M, 2TB
- 661-14117, Logic Board, 2.6GHz, i7, 32GB, 5300M, 4TB
- 661-14118, Logic Board, 2.6GHz, i7, 32GB, 5300M, 8TB
- 661-14123, Logic Board, 2.6GHz, i7, 64GB, 5300M, 512GB
- 661-14124, Logic Board, 2.6GHz, i7, 64GB, 5300M, 1TB
- 661-14125, Logic Board, 2.6GHz, i7, 64GB, 5300M, 2TB
- 661-14126, Logic Board, 2.6GHz, i7, 64GB, 5300M, 4TB
- 661-14127, Logic Board, 2.6GHz, i7, 64GB, 5300M, 8TB

Radeon Pro 5500M 4GB

- 661-14879, Logic Board, 2.6GHz, i7, 16GB, 5500M 4GB, 512GB
- 661-14880, Logic Board, 2.6GHz, i7, 16GB, 5500M 4GB, 1TB
- 661-14881, Logic Board, 2.6GHz, i7, 16GB, 5500M 4GB, 2TB

- 661-14882, Logic Board, 2.6GHz, i7, 16GB, 5500M 4GB, 4TB
- 661-14883, Logic Board, 2.6GHz, i7, 16GB, 5500M 4GB, 8TB
- 661-14884, Logic Board, 2.6GHz, i7, 32GB, 5500M 4GB, 512GB
- 661-14885, Logic Board, 2.6GHz, i7, 32GB, 5500M 4GB, 1TB
- 661-14886, Logic Board, 2.6GHz, i7, 32GB, 5500M 4GB, 2TB
- 661-14887, Logic Board, 2.6GHz, i7, 32GB, 5500M 4GB, 4TB
- 661-14888, Logic Board, 2.6GHz, i7, 32GB, 5500M 4GB, 8TB
- 661-14889, Logic Board, 2.6GHz, i7, 64GB, 5500M 4GB, 512GB
- 661-14890, Logic Board, 2.6GHz, i7, 64GB, 5500M 4GB, 1TB
- 661-14891, Logic Board, 2.6GHz, i7, 64GB, 5500M 4GB, 2TB
- 661-14892, Logic Board, 2.6GHz, i7, 64GB, 5500M 4GB, 4TB
- 661-14893, Logic Board, 2.6GHz, i7, 64GB, 5500M 4GB, 8TB

#### Radeon Pro 5500M 8GB

- 661-14109, Logic Board, 2.6GHz, i7, 16GB, 5500M 8GB, 512GB
- 661-14110, Logic Board, 2.6GHz, i7, 16GB, 5500M 8GB, 1TB
- 661-14111, Logic Board, 2.6GHz, i7, 16GB, 5500M 8GB, 2TB
- 661-14112, Logic Board, 2.6GHz, i7, 16GB, 5500M 8GB, 4TB
- 661-14113, Logic Board, 2.6GHz, i7, 16GB, 5500M 8GB, 8TB
- 661-14119, Logic Board, 2.6GHz, i7, 32GB, 5500M 8GB, 512GB
- 661-14120, Logic Board, 2.6GHz, i7, 32GB, 5500M 8GB, 1TB
- 661-14121, Logic Board, 2.6GHz, i7, 32GB, 5500M 8GB, 2TB
- 661-14901, Logic Board, 2.6GHz, i7, 32GB, 5500M 8GB, 4TB
- 661-14122, Logic Board, 2.6GHz, i7, 32GB, 5500M 8GB, 8TB
- 661-14128, Logic Board, 2.6GHz, i7, 64GB, 5500M 8GB, 512GB
- 661-14129, Logic Board, 2.6GHz, i7, 64GB, 5500M 8GB, 1TB
- 661-14130, Logic Board, 2.6GHz, i7, 64GB, 5500M 8GB, 2TB
- 661-14131, Logic Board, 2.6GHz, i7, 64GB, 5500M 8GB, 4TB
- 661-14899, Logic Board, 2.6GHz, i7, 64GB, 5500M 8GB, 8TB

## 2.3GHz 8-core Intel Core i9

#### Radeon Pro 5500M 4GB

- 661-14132, Logic Board, 2.3GHz, i9, 16GB, 5500M 4GB, 1TB
- 661-14133, Logic Board, 2.3GHz, i9, 16GB, 5500M 4GB, 2TB
- 661-14134, Logic Board, 2.3GHz, i9, 16GB, 5500M 4GB, 4TB
- 661-14135, Logic Board, 2.3GHz, i9, 16GB, 5500M 4GB, 8TB
- 661-14139, Logic Board, 2.3GHz, i9, 32GB, 5500M 4GB, 1TB
- 661-14140, Logic Board, 2.3GHz, i9, 32GB, 5500M 4GB, 2TB
- 661-14903, Logic Board, 2.3GHz, i9, 32GB, 5500M 4GB, 4TB
- 661-14141, Logic Board, 2.3GHz, i9, 32GB, 5500M 4GB, 8TB
- 661-14146, Logic Board, 2.3GHz, i9, 64GB, 5500M 4GB, 1TB
- 661-14147, Logic Board, 2.3GHz, i9, 64GB, 5500M 4GB, 2TB
- 661-14148, Logic Board, 2.3GHz, i9, 64GB, 5500M 4GB, 4TB
- 661-14149, Logic Board, 2.3GHz, i9, 64GB, 5500M 4GB, 8TB

#### Radeon Pro 5500M 8GB

- 661-14136, Logic Board, 2.3GHz, i9, 16GB, 5500M 8GB, 1TB
- 661-14900, Logic Board, 2.3GHz, i9, 16GB, 5500M 8GB, 2TB
- 661-14137, Logic Board, 2.3GHz, i9, 16GB, 5500M 8GB, 4TB
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- 661-14142, Logic Board, 2.3GHz, i9, 32GB, 5500M 8GB, 1TB
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- 661-14144, Logic Board, 2.3GHz, i9, 32GB, 5500M 8GB, 4TB
- 661-14145, Logic Board, 2.3GHz, i9, 32GB, 5500M 8GB, 8TB

- 661-14150, Logic Board, 2.3GHz, i9, 64GB, 5500M 8GB, 1TB
- 661-14151, Logic Board, 2.3GHz, i9, 64GB, 5500M 8GB, 2TB
- 661-14152, Logic Board, 2.3GHz, i9, 64GB, 5500M 8GB, 4TB
- 661-14153, Logic Board, 2.3GHz, i9, 64GB, 5500M 8GB, 8TB

## 2.4GHz 8-core Intel Core i9

### Radeon Pro 5300M

- 661-14154, Logic Board, 2.4GHz, i9, 16GB, 5300M, 512GB
- 661-14155, Logic Board, 2.4GHz, i9, 16GB, 5300M, 1TB
- 661-14894, Logic Board, 2.4GHz, i9, 16GB, 5300M, 2TB
- 661-14156, Logic Board, 2.4GHz, i9, 16GB, 5300M, 4TB
- 661-14157, Logic Board, 2.4GHz, i9, 16GB, 5300M, 8TB
- 661-14167, Logic Board, 2.4GHz, i9, 32GB, 5300M, 512GB
- 661-14168, Logic Board, 2.4GHz, i9, 32GB, 5300M, 1TB
- 661-14169, Logic Board, 2.4GHz, i9, 32GB, 5300M, 2TB
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- 661-14179, Logic Board, 2.4GHz, i9, 64GB, 5300M, 512GB
- 661-14906, Logic Board, 2.4GHz, i9, 64GB, 5300M, 1TB
- 661-14180, Logic Board, 2.4GHz, i9, 64GB, 5300M, 2TB
- 661-14181, Logic Board, 2.4GHz, i9, 64GB, 5300M, 4TB
- 661-14182, Logic Board, 2.4GHz, i9, 64GB, 5300M, 8TB

### Radeon Pro 5500M 4GB

- 661-14895, Logic Board, 2.4GHz, i9, 16GB, 5500M 4GB, 512GB
- 661-14158, Logic Board, 2.4GHz, i9, 16GB, 5500M 4GB, 1TB
- 661-14159, Logic Board, 2.4GHz, i9, 16GB, 5500M 4GB, 2TB
- 661-14160, Logic Board, 2.4GHz, i9, 16GB, 5500M 4GB, 4TB
- 661-14161, Logic Board, 2.4GHz, i9, 16GB, 5500M 4GB, 8TB
- 661-14896, Logic Board, 2.4GHz, i9, 32GB, 5500M 4GB, 512GB
- 661-14171, Logic Board, 2.4GHz, i9, 32GB, 5500M 4GB, 1TB
- 661-14172, Logic Board, 2.4GHz, i9, 32GB, 5500M 4GB, 2TB
- 661-14173, Logic Board, 2.4GHz, i9, 32GB, 5500M 4GB, 4TB
- 661-14174, Logic Board, 2.4GHz, i9, 32GB, 5500M 4GB, 8TB
- 661-14897, Logic Board, 2.4GHz, i9, 64GB, 5500M 4GB, 512GB
- 661-14183, Logic Board, 2.4GHz, i9, 64GB, 5500M 4GB, 1TB
- 661-14184, Logic Board, 2.4GHz, i9, 64GB, 5500M 4GB, 2TB
- 661-14185, Logic Board, 2.4GHz, i9, 64GB, 5500M 4GB, 4TB
- 661-14186, Logic Board, 2.4GHz, i9, 64GB, 5500M 4GB, 8TB

### Radeon Pro 5500M 8GB

- 661-14162, Logic Board, 2.4GHz, i9, 16GB, 5500M 8GB, 512GB
- 661-14163, Logic Board, 2.4GHz, i9, 16GB, 5500M 8GB, 1TB
- 661-14164, Logic Board, 2.4GHz, i9, 16GB, 5500M 8GB, 2TB
- 661-14165, Logic Board, 2.4GHz, i9, 16GB, 5500M 8GB, 4TB
- 661-14166, Logic Board, 2.4GHz, i9, 16GB, 5500M 8GB, 8TB
- 661-14175, Logic Board, 2.4GHz, i9, 32GB, 5500M 8GB, 512GB
- 661-14176, Logic Board, 2.4GHz, i9, 32GB, 5500M 8GB, 1TB
- 661-14177, Logic Board, 2.4GHz, i9, 32GB, 5500M 8GB, 2TB
- 661-14178, Logic Board, 2.4GHz, i9, 32GB, 5500M 8GB, 4TB
- 661-14907, Logic Board, 2.4GHz, i9, 32GB, 5500M 8GB, 8TB
- 661-14187, Logic Board, 2.4GHz, i9, 64GB, 5500M 8GB, 512GB
- 661-14188, Logic Board, 2.4GHz, i9, 64GB, 5500M 8GB, 1TB
- 661-14189, Logic Board, 2.4GHz, i9, 64GB, 5500M 8GB, 2TB
- 661-14190, Logic Board, 2.4GHz, i9, 64GB, 5500M 8GB, 4TB
- 661-14191, Logic Board, 2.4GHz, i9, 64GB, 5500M 8GB, 8TB

## **12. Vent/Antenna Module**

- 923-03931

## **13. Display Clutch Cover, Right**

- 923-03936

## **14. Touch ID Board**

- 661-15683

## **15. Audio Board**

- 923-03902, Space Gray
- 923-03903, Silver

## **16. I/O Board, Right**

- 923-03934

## **17. eDP Cowling, Upper**

- 923-03940

## **18. eDP Cowling, Lower**

- 923-03939

## **19. eDP flex**

- 923-03933

## **20. Display Clutch Cover, Left**

- 923-03935

## **21. Lid Angle Sensor (LAS) Module**

- 661-14647

## **22. I/O Board, Left**

- 923-03934

## **23. Top Case with Battery (includes speakers, trackpad flex cable, keyboard flex cable, tri-microphone, trackpad, keyboard, Touch Bar flex cable, and Touch ID flex cable)**

- 661-13161, space gray
- 661-13162, silver

**Note:** Regional top cases have the same base part number, but they include a language code prefix (for example, Italian = T661-13161). Be sure to choose the correct keyboard language when ordering a top case. The language prefixes are:



- AB: Arabic
- B: British (Great Britain)
- BG: Bulgarian
- C: Canadian French
- CH: Chinese Simplified
- CR: Croatian
- CZ: Czech
- D: German
- DK: Danish
- E: Spanish
- F: French
- FN: Belgian
- GR: Greek
- H: Norwegian Bokmal
- HB: Hebrew
- IS: Icelandic
- J: Japanese
- KH: Korean
- MG: Hungarian
- N: Dutch
- PO: Portuguese
- RO: Romanian
- RS: Russian
- S: Swedish
- SF: Swiss French
- SL: Slovak
- SM: Swiss Multilingual
- T: Italian
- TA: Taiwanese
- TH: Thai
- TQ: Turkish (Turkey)
- TU: Turkish (Turkish)
- VN: Vietnam
- Z: English International


Top case keyboards may not be available in all localizations.















## **24. Display Assembly**

- 661-14200, space gray
- 661-14201, silver

# Screw Chart

## Screw Chart for MacBook Pro (16-inch, 2019)

<p>923-03964, Silver Pentalobe</p>  <p>Bottom Case, Shoulders (2)</p>	<p>923-03965, Silver Pentalobe</p>  <p>Bottom Case, Lower (4)</p>	<p>923-03955, Space Gray Pentalobe</p>  <p>Bottom Case, Shoulders (2)</p>
<p>923-03963, Space Gray Pentalobe</p>  <p>Bottom Case, Lower (4)</p>	<p>923-03912 Torx T5</p>  <p>BMU Screw (1)</p>	<p>923-01185 Torx T3</p>  <p>Spring Tensioners (4)</p>
<p>923-01286 Torx T3</p>  <p>Display Clutch Covers (4)</p>	<p>923-01173 Torx T8</p>  <p>Display Assembly Hinge (6)</p>	<p>923-01512 1IPR</p>  <p>Vent/Antenna Module (16)</p>
<p>923-03913 Torx T3</p>  <p>Logic Board (3)</p>	<p>923-01500 Torx T5</p>  <p>Logic Board (5)</p>	<p>923-03968 Torx T5</p>  <p>Logic Board (2)</p>
<p>923-03972 Torx T3</p>  <p>eDP Flex Cable to Logic Board (2)</p>	<p>923-01285 Torx T3</p>  <p>eDP Flex Cable Upper Cowling (2)</p>	<p>923-01510 Torx T3</p>  <p>eDP Flex Cable Lower Cowling (2)</p>

<p>923-01277 Torx T5</p>  <p>TCON Board Screws (4)</p>	<p>923-01502 Torx T8</p>  <p>Heat Sink, Left</p>	<p>923-01505 Torx T8</p>  <p>Heat Sink, Right</p>
<p>923-03971 Torx T5</p>  <p>Heat Sink Flexures GPU (4)</p>	<p>923-03970 Torx T5</p>  <p>Heat Sink Flexures CPU (4)</p>	<p>923-01506 Torx T3</p>  <p>Touch ID Board Flex Cowling (2)</p>
<p>923-03911 Torx T3</p>  <p>Touch ID (2)</p>	<p>923-03910 Torx T3</p>  <p>Touch ID (4)</p>	<p>923-01501 Torx T3</p>  <p>Trackpad Flex Cowling Touch Bar Display Flex Cowling</p>
<p>923-03969 Torx 3</p>  <p>Touch Bar Touch/LAS Cowling (2) I/O Board Cowling (Left and Right) (4)</p>	<p>923-03966 Torx T3</p>  <p>Fans (Left and Right) (4)</p>	<p>923-03967 Torx T5</p>  <p>Fans (Left and Right) (4) I/O Board (Left and Right) (4)</p>
<p>923-03909 1IPR</p>  <p>Lid Angle Sensor (LAS) Module</p>	<p>923-02530 Torx T3</p>  <p>Audio Board Screw, washer included (3)</p>	

# Screw Location Diagrams

## Screw Location Diagrams for MacBook Pro (16-inch, 2019)

### Bottom Case

- Pentalobe: (position 1)
  - 923-03964, Silver
  - 923-03955, Space Gray



- Pentalobe: (position 2)
  - 923-03965, Silver
  - 923-03963, Space Gray

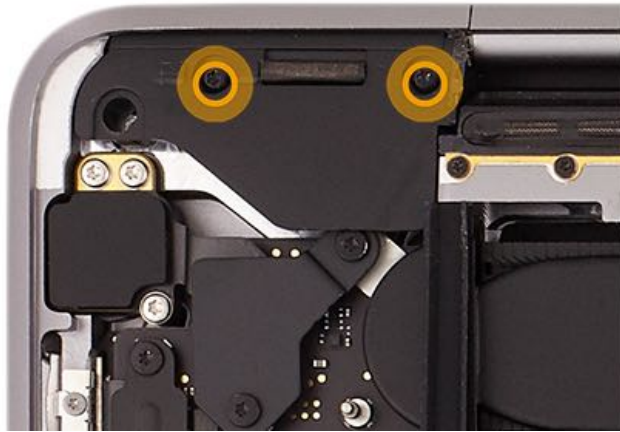


### Clutch Covers

- T3: 923-01286







### Audio Board

- T3: 923-02530



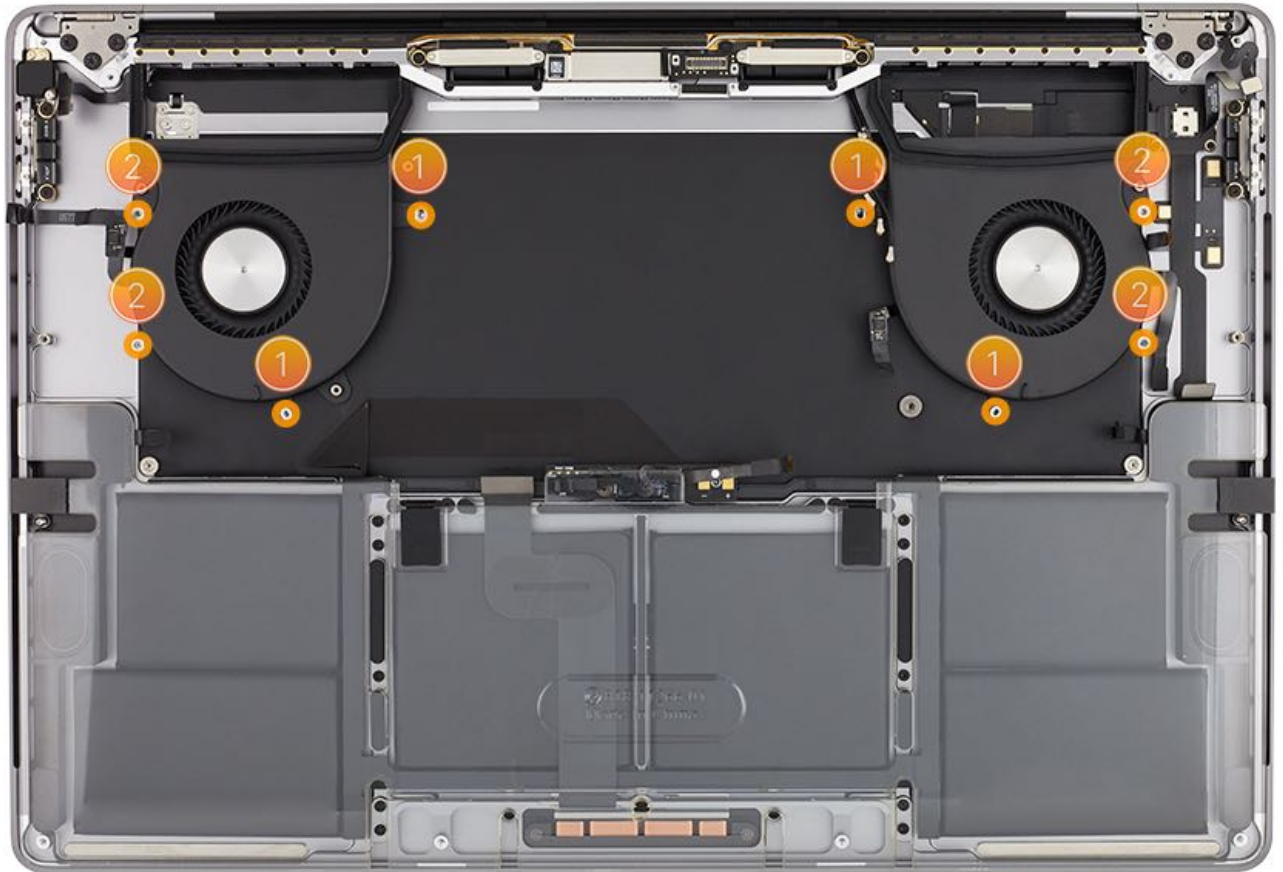
### Right and Left Fans

- T5: 923-03967 (position 1)

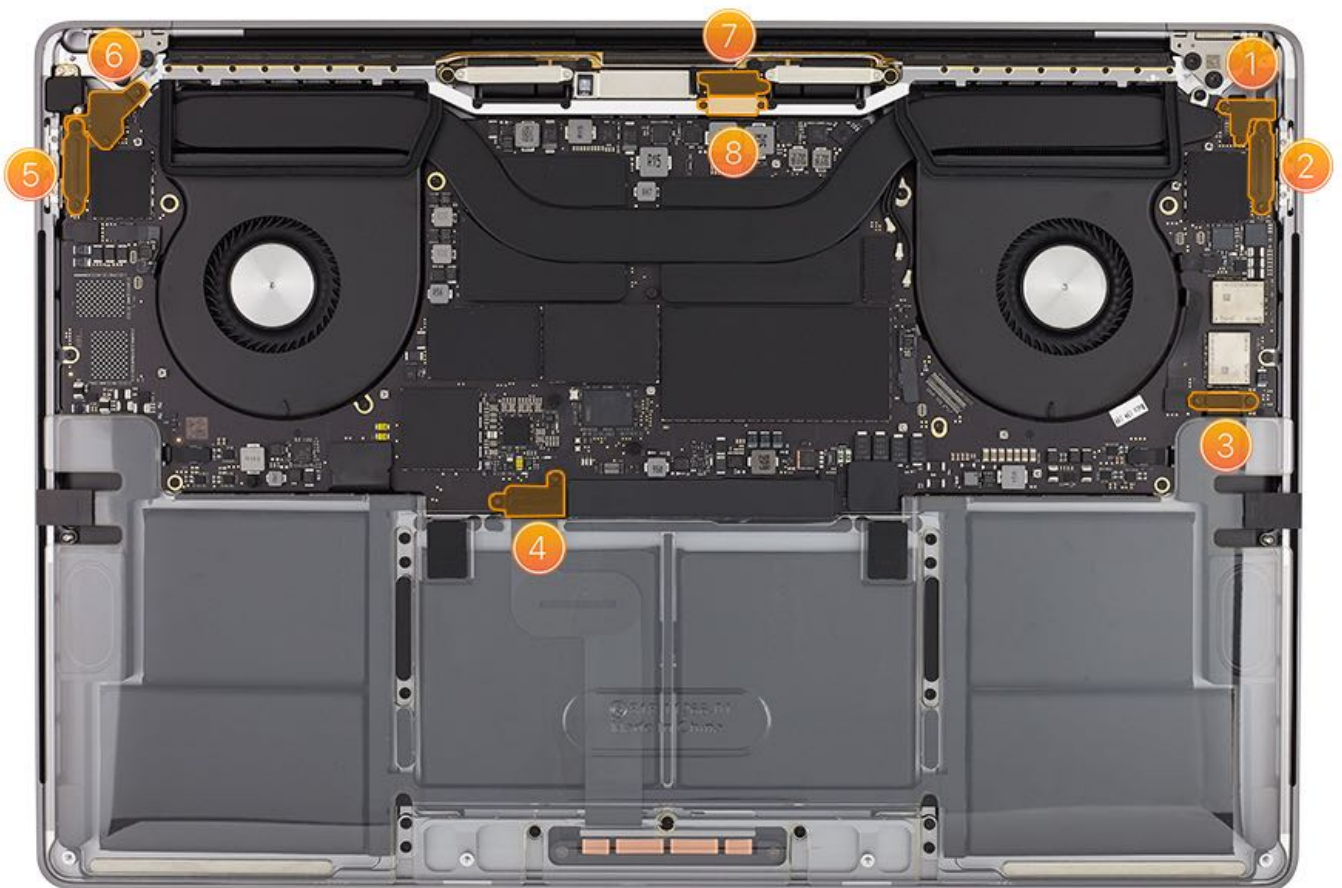


- T3: 923-03966 (position 2)





#### Logic Board Cowling Screws



1 - Touch Bar Touch/LAS cowling

2 and 5 - I/O Board cowling (Left and Right)

- T3: 923-03969



3 - Touch Bar Display Flex Cowling

4 - Trackpad Flex Cowling

- T3: 923-01501



6 - Touch ID and Audio Board cowling

- T3: 923-01506



7 - Lower eDP flex cable cowling

- T3: 923-01510



8 - Upper eDP flex cable cowling

- T3: 923-01285



### Logic Board Screws

- T5: (position 1)
  - 923-01500



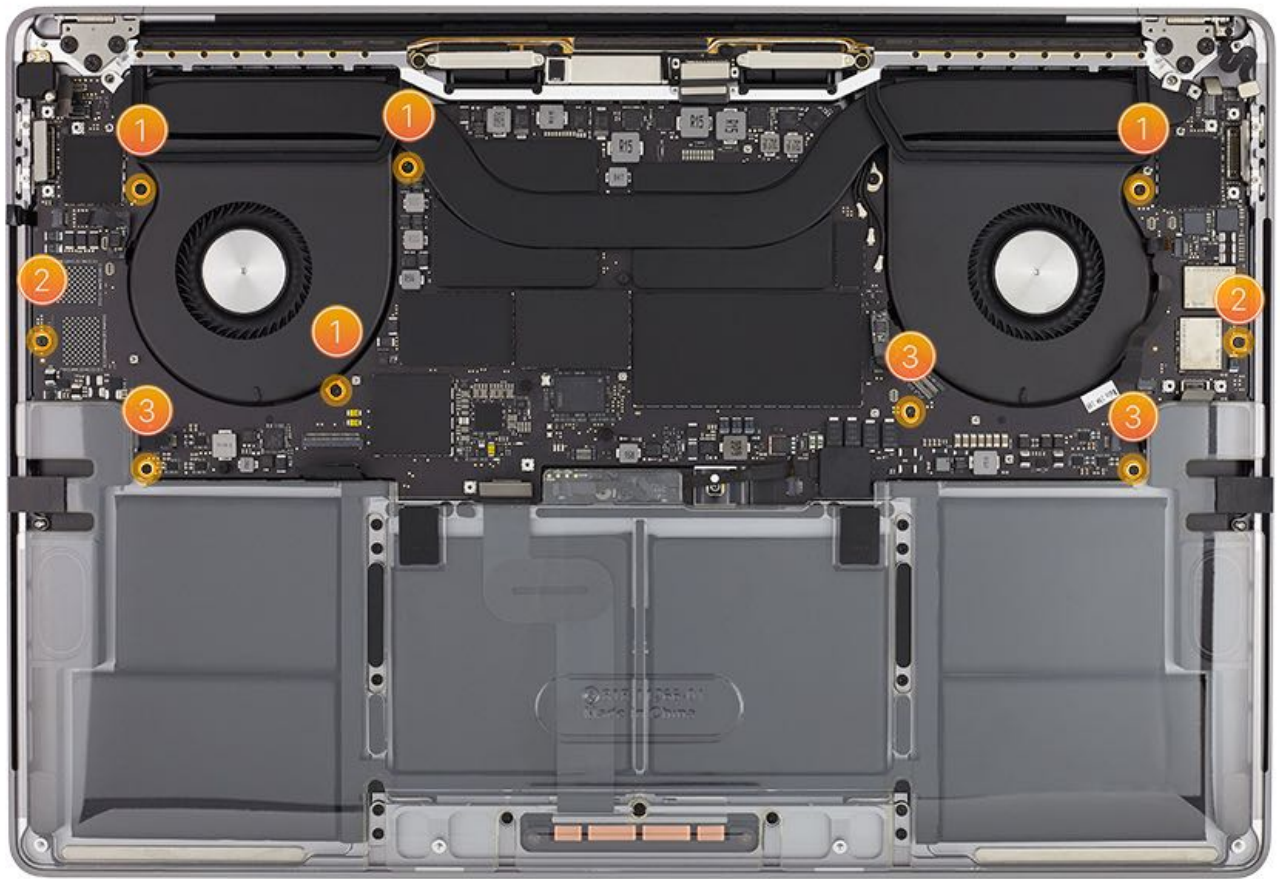
- T5: (position 2)
  - 923-03968



- T3: (position 3)
  - 923-03913







## BMU

- T5: 923-03912





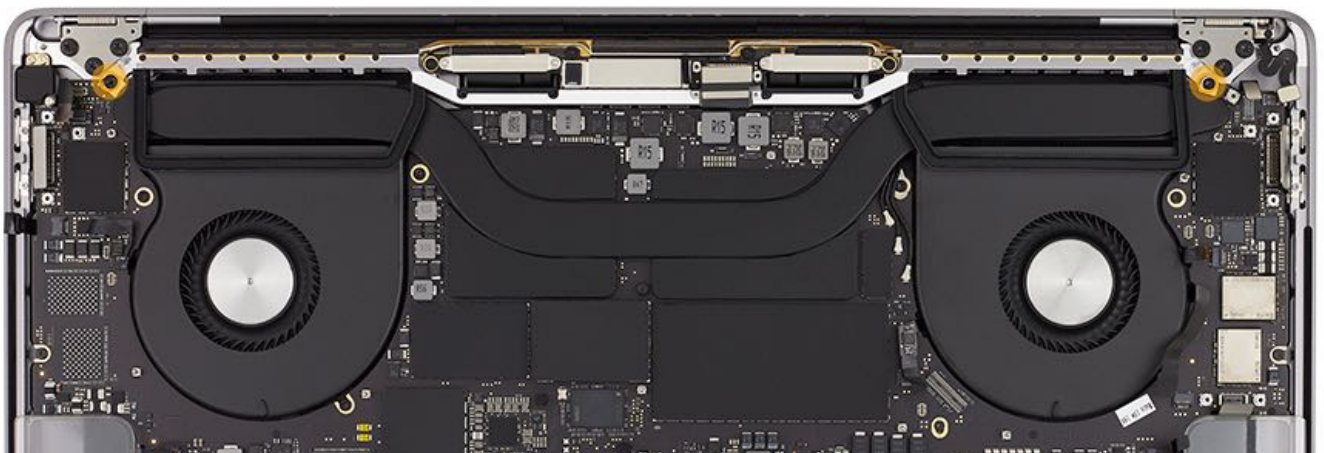


#### Heat Sink

- T8: 923-01502 (left)

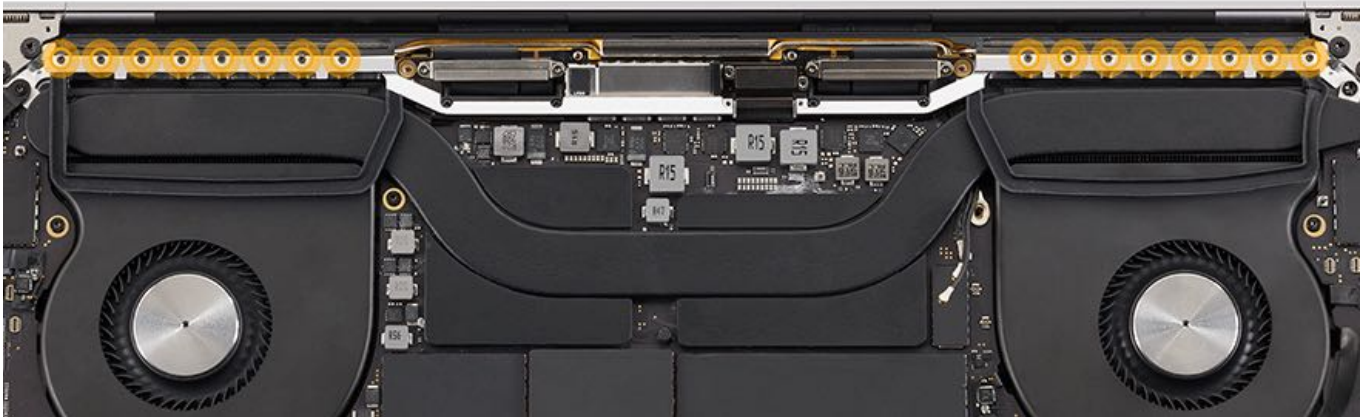


- T8: 923-01505 (right) **Note:** The right screw is a screw within a screw.



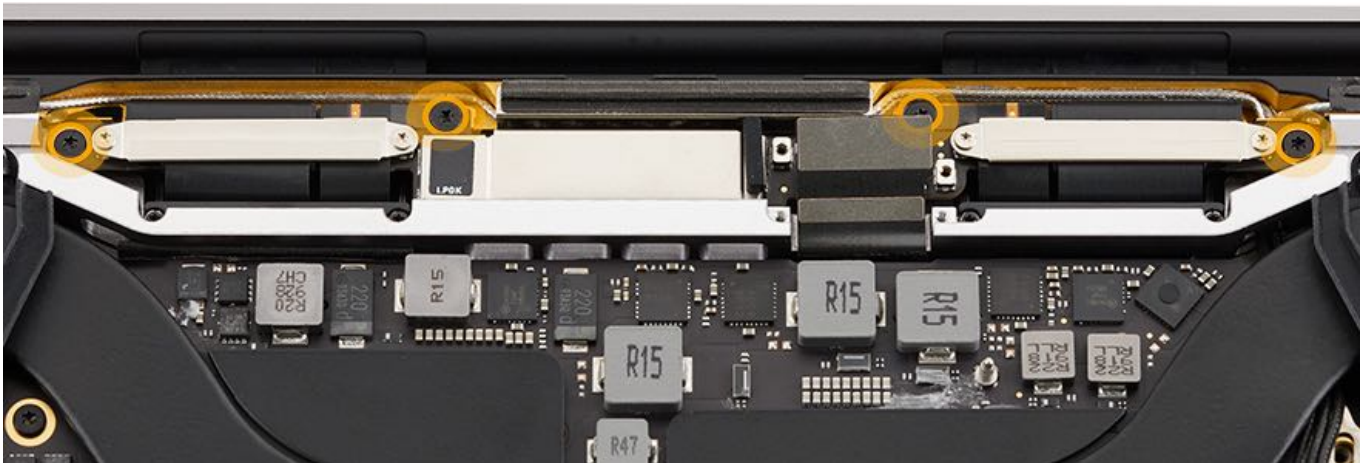
#### Vent/Antenna Module

- 1IPR: 923-01512



### TCON Board

- T5: 923-01277



### Display Hinge Screws

- T8: 923-01173



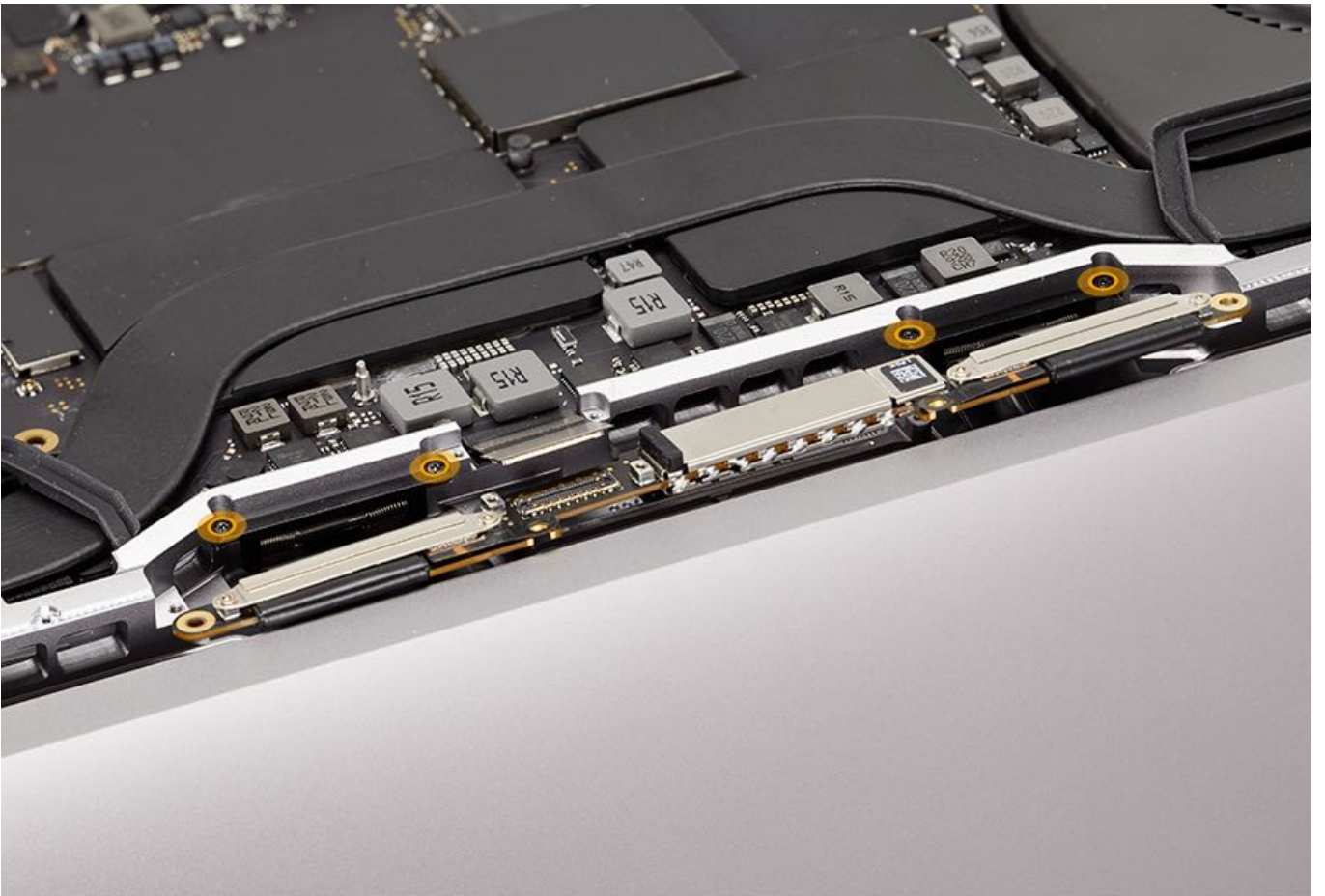


### Spring Tensioners

- T3: 923-01185







#### Touch ID Board

- T3: 923-03911







- T3: 923-03910

